

**Guiding Cane**

GNG 2101

**Deliverable D**

Team B32 - THE HAZARDS

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# INTRODUCTION

The objective of this deliverable is to take the feedback from the second client meeting and create a prototype that will be tested as well as create a preliminary Bill of Materials(BOM). The team will test the updated prototype based on the design metrics and target specifications. The BOM list will determine whether we are within the budget and help determine which products are affordable and are of good quality. The team will additionally complete the ITP metrics which provides peer feedback and aid in conflict resolution as well as identify individual strengths and weaknesses.

# DETAILED DESIGN

## 2.1 Introduction

Designing the guiding cane is an important step in creating the final product. Obtaining feedback from the client is crucial in understanding the needs as well as the wants. This will lay a foundation for the design of the prototype. Prioritizing the clients needs will allow the team to focus on designing those components first and well. Diagrams and flowcharts well as free body diagrams will be used in order to design prototype one.

## 2.2 Client Feedback and Needs

In this client meeting, the team was able to explain the most current prototype design that has been created (as seen in deliverable C, sections 2.5 and 2.6). From this explanation came really useful feedback from the client. The team was able to engage in helpful conversation with the client to further their understanding of what the client was actually looking for as well as brainstorm more ideas with the client. Based on the conversations had during this meeting, the team now knows that the client really likes the idea of changeable tips and handles, a folding joint/hinge in the middle, a fast assembly time (transition from the tip to the handle), a more durable material than the standard aluminum canes that only have a lifespan of approximately 2-4 years, and the client prefers the idea of the telescoping cane to the foldable cane but really likes the idea of combining the two concepts.

This conversation led to the generation of some good ideas and improvements that can be made to the latest design. The client needs have been updated so that the group can see how the importance of certain elements has changed since the last client meeting. These needs follow the same priority scale as the needs stated in deliverable B, on a scale of 1-5, 5 being a higher priority and 1 being a lower priority.

**Table 1 - Priority of Client Needs**

| **Customer Needs** | **Priority (1-5)** |
| --- | --- |
| Easily portable (small in size) | 4 |
| Lightweight | 5 |
| Easy to assemble and requires minimal assembly time | 4 |
| Durable materials for the cane, the tip, and the handles | 3 |
| Comfortable handles (to hold for long periods of time) | 2 |
| Flexible orientation of the cane and fits in narrow spaces | 3 |
| Allows user to maintain social distancing | 5 |
| Signal to notify of nearby hazards | 1 |

## 2.3 Detailed Design

The guiding cane concept is a concept with simple subsystems. All subsystems have been carefully applied to allow the client to have a highly effective cane for daily use.

The following Use Case Diagram gives a brief overview of the guiding cane’s interaction with its users.

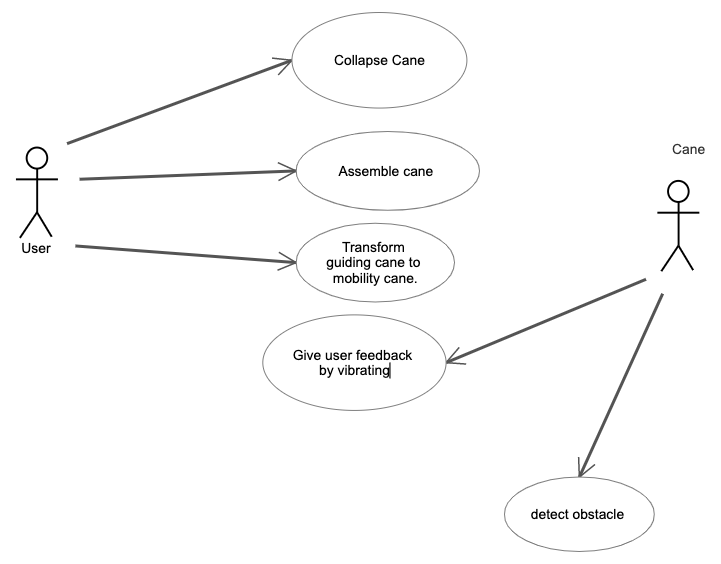


Figure 1 - Cane’s Use Case Diagram

The Use Case Diagram above lists out some key features in the guiding cane. The cane is expected to collapse and assemble easily. The cane is also expected to have a system to detect obstacles. This system is implemented in the guiding cane design as a safety feature for the cane’s users.

Below is a flow chart describing the guiding cane’s safety system.

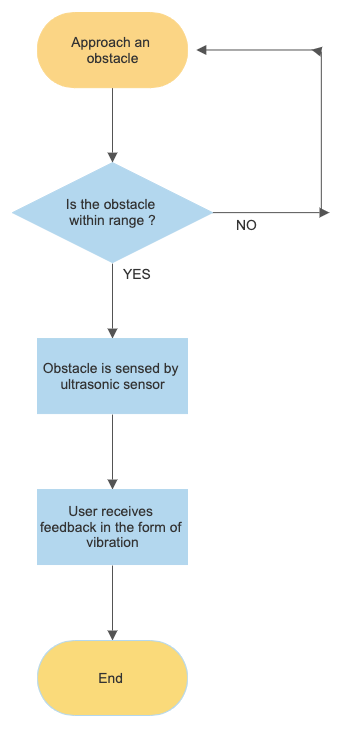


Figure 2 - Guiding Cane’s Safety Feature

From the picture above the ultrasonic sensor senses obstacles. If the obstacle detected is beyond a certain range the handle vibrates as a sign of warning that the user is approaching an obstacle and should be careful.

The Guiding Cane’s safety feature and the cane’s ability to collapse and assemble is to be embodied in a physical structure with simple mechanical features. Figure X gives a clear visual representation of what the cane looks like.



Figure 3 - Guiding Cane Physical Concept

The cane’s method of retracting and collapsing is similar to how a telescope contracts and extends. Pulling the end of the cane would make it extend and pushing it would make it collapse. The cane is expected to be pushed or pulled until a click sound is made; this just ensures that it is steady and will not move out of place.

## 2.4 Critical Product Assumptions

The cane must satisfy all the conditions set by the clients throughout the client meets. A suitable material such as carbon fiber tubing must be used to ensure durability while maintaining a light overall weight. The cane must be able to withstand daily use and abuse, we tested this by dropping it from 3 stories a few times until it fractured and a benchmark was made. A comfortable grip must be used to ensure ease of use over long periods of time.

# PROTOTYPE 1

## 3.1 Introduction

Creating the guiding cane prototype has multiple processes before prototype testing can occur. Prototype 1 will be created based on the clients needs and wants. The prototype will be designed virtually and thereafter physically assembled for both theoretical and practical testing. Understanding the purpose of the guiding cane is crucial to creating a successful prototype that will meet the client’s needs and wants. After the prototype has been created it will undergo a series of tests that will display how useful the prototype is and if it's up to the clients specifications.

## 3.2 Prototype Creation

The main method of creating this prototype is through CAD diagrams. Three components were created; the spindle, and the two telescopic rods. The CAD diagrams allowed for a clear observation of whether these components were compatible. Thereafter the prototype will be 3D printed with PLA material. The PLA material will provide a strong structural base but will also be lightweight for easy transportation.

## 3.3 Purpose

The purpose of this prototype is to create a half-scale of two small components of the prototype and to perform a series of tests that will determine if there are any issues. A drop test will determine the structural integrity of the prototype. There will be a number of different drop tests from a 4 story building as well as a slam test on concrete. Connecting the pieces and observing how malleable and sturdy the product is will help determine if the product is compatible with the other necessary parts. The series of tests will allow possible errors to arise and therefore can be corrected in further prototype tests. These tests will also determine if the prototype is matching the client’s needs.

## 3.4 Prototype Testing

Team 32’s first prototype’s focused on testing the structural integrity of the material used(PLA). This prototype will allow the team to observe if it’s meeting the client’s needs and priorities. This prototype also includes CAD models and pictures of the prototype testing. The test plan will consist of a drop test, slam test, and joint compatibility test. These tests will be conducted from a 62ft(four storey building) as well as from a 190cm height. This will display the physical integrity of the prototype to observe the amount of stress that can be applied upon it till it’s breaking point. These tests will give the team a clear idea of what needs to be added and or removed. The 3D printing of the CAD models will demonstrate if there are any errors within the CAD file. Below are a few CAD models of the printed prototype.

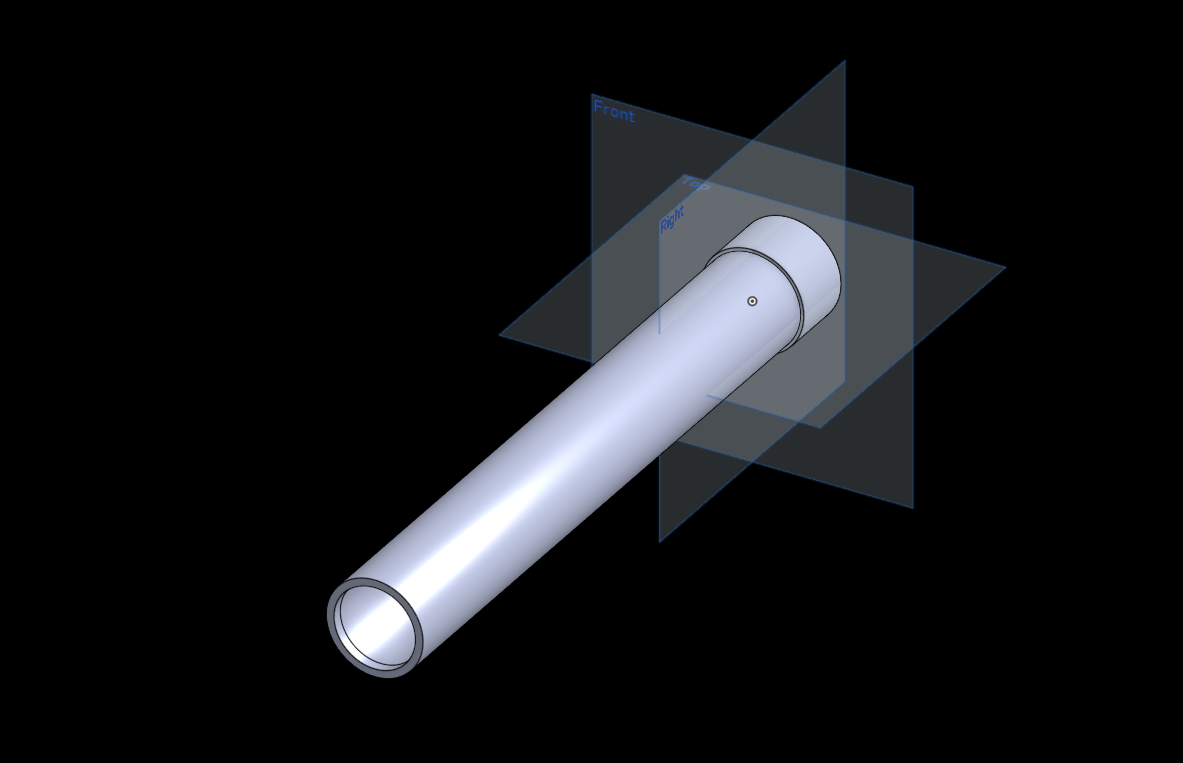
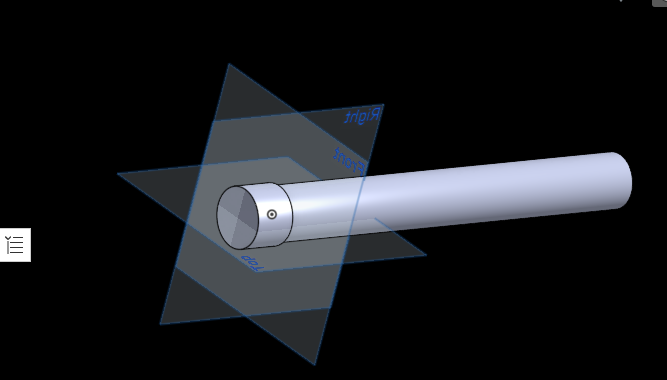


Figure 4 - Telescopic Joint

Figure 5 - Telescopic Joint End

The prototype test proceeded successfully and the necessary observations were made. The first test that was conducted was the compatibility test; where the two printed materials will be joined together. The test proceeded successfully and can be seen in Figure 6. Thereafter the drop test was performed two different times in two positions. The first position was vertical and it was dropped from a 4 story building suffering zero damages. This test proved that the structural integrity of the PLA material is fairly strong. The second drop was performed at a 4 story building at a diagonal angle. This test resulted in a small fracture which can be seen in Figure 7. The slam test was performed with the end piece by slamming it against concrete from a standing position. This test resulted in zero damage to the prototype and proved that the piece is shock absorbent. The joined parts were 12 inches in length and survived the first drop as well as the slam test from both 62ft and 190cm.



Figure 6 - Joined Parts



Figure 7 - Post Drop Test

These tests demonstrated the PLA material’s limitations and how the material is shock absorbent. The fracture of the prototype could be because of the thickness being 0.1cm. Increasing the thickness of the prototype could increase the structural integrity of the prototype. Redesigning the prototype with a stronger material could also be a solution such as aluminum. Though the test resulted in the fracture of the prototype it allows us to choose a more suitable replacement to suit the client’s needs. The testing of this prototype was successful and provided the necessary errors that will be addressed in the coming deliverables.

# 

# B.O.M.

**Table 2 - B.O.M.**

| **Materials** | **Amount Needed** | **Cost ($)** |
| --- | --- | --- |
| 3D printer | 1 | 0 |
| Solid Works software | 1 | 0 |
| PLA filament |  | 0 |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

**Table 3 - B.O.M. of Final Cane**

| **Materials** | **Amount Needed** | **Cost ($)** |
| --- | --- | --- |
| Arduino | 1 | 16 |
| Carbon Fiber Tubing | 1 | 15 |
| Grip/Handle | 1 |  |
| Hinge | 1 |  |
| Workshop Session | 1 | 0 |
|  |  |  |
|  |  |  |
|  |  |  |

# CLIENT MEETING

***Rough Interview Schedule/ “Path”*** *(duration and basic activities/question areas):*

1. (5 minutes): Ask about durability requirements

2. (5 minutes): Figure out new and unique features to implement based on client feedback.

3. (5 minutes): Favorite and most disliked aspects of prototype?

4. (5 minutes): does the prototype fulfill your expectations?

***Specific Questions*** *(order can be adjusted to maintain ‘natural’ conversation flow):*

1. How durable should the prototype be?
2. How can we add or remove other features that may separate this product from others?
3. What makes you excited to be able to potentially use this product?
4. Is this design what you were imagining after the last time we discussed the design?

# PROJECT PLAN UPDATE

The following figure is the Gantt chart of the tasks assigned for this deliverable. Most of the tasks can be completed at any time before the due date, however, any dependencies that there may be have been given to the corresponding tasks.

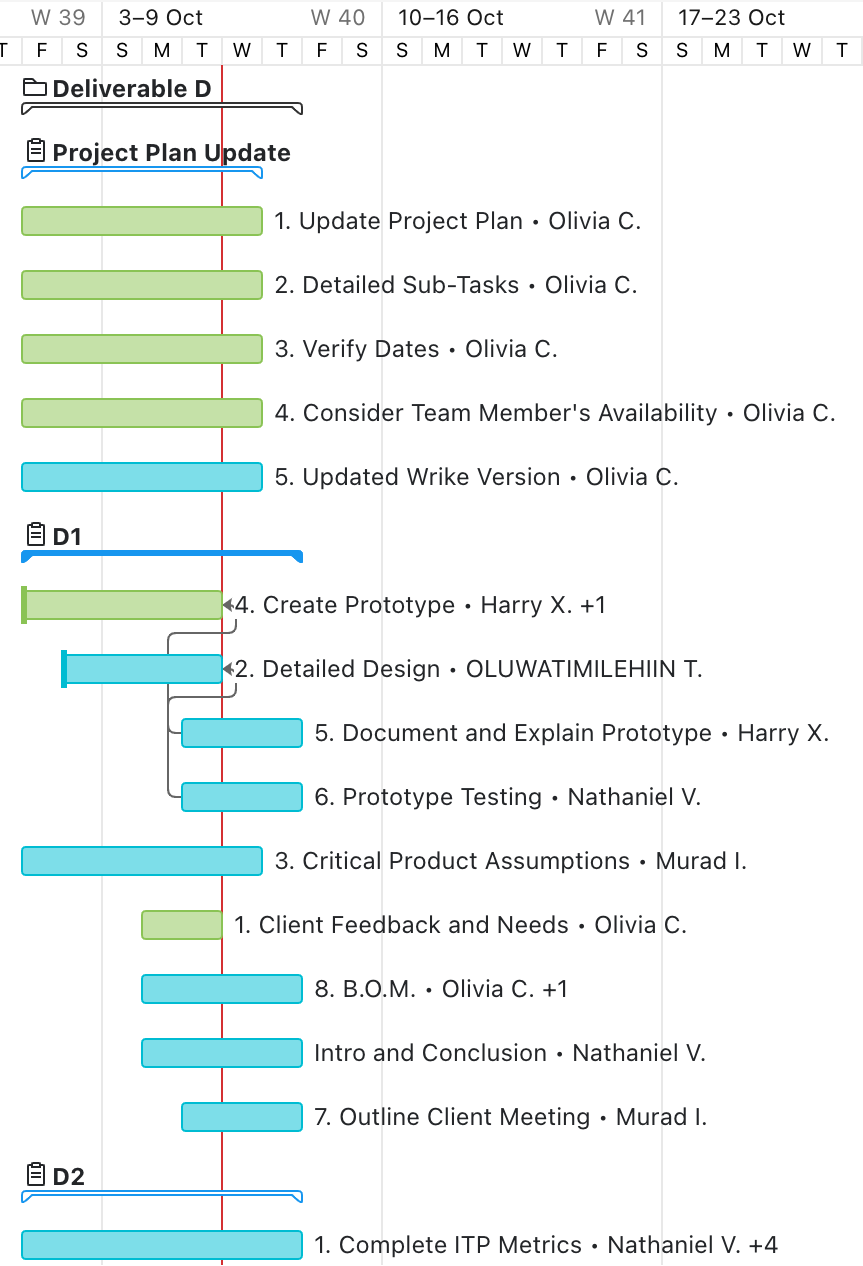


Figure 8 - Deliverable D Gantt Chart

## 6.1 Detailed Sub-Tasks

Each main component of the deliverable is given a section under the deliverable folder in Wrike. This main component (ex: D1) is given a general description of what needs to be done overall and the dates that are given for the entire section.

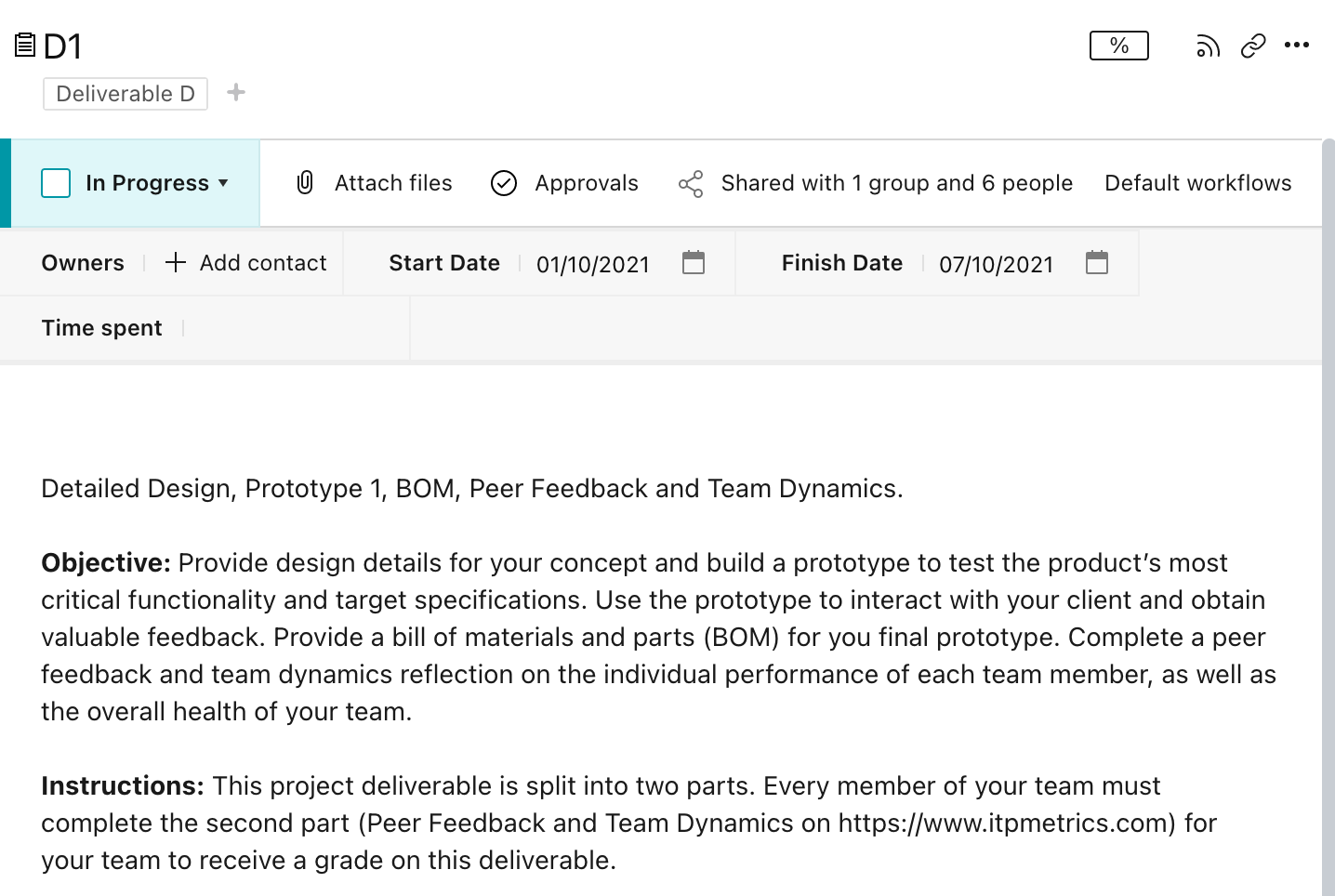


Figure 9 - D1 Description

Under each main component is a list of all of the individual tasks that must be completed. These individual tasks are given a detailed description of what needs to be done specifically, the dates in which have been allotted for that specific task, and the individuals responsible for completing that task.

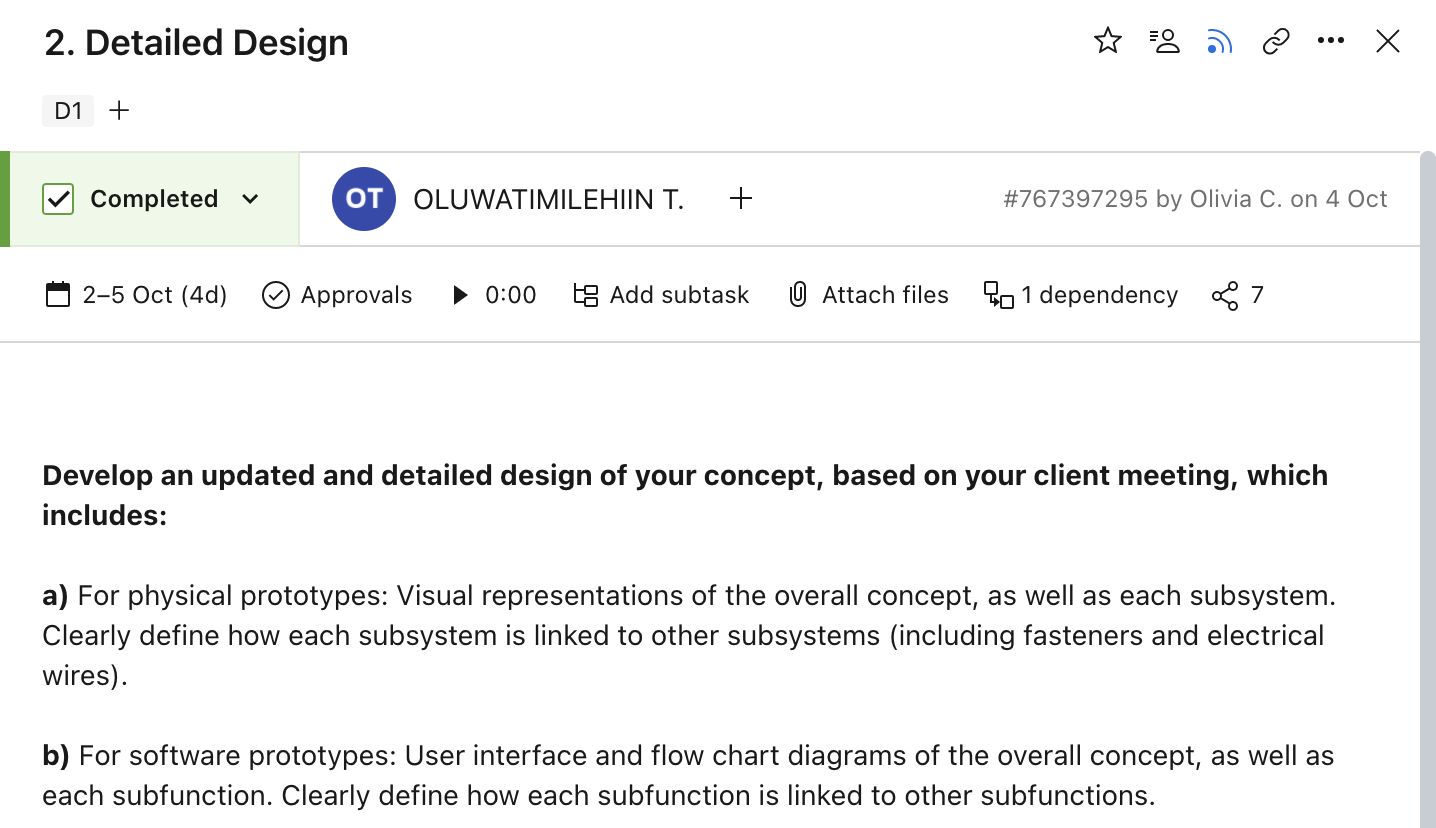


Figure 10 - Individual Task (Example D1-2)



Figure 11 - Individual Task (Example D1-6)

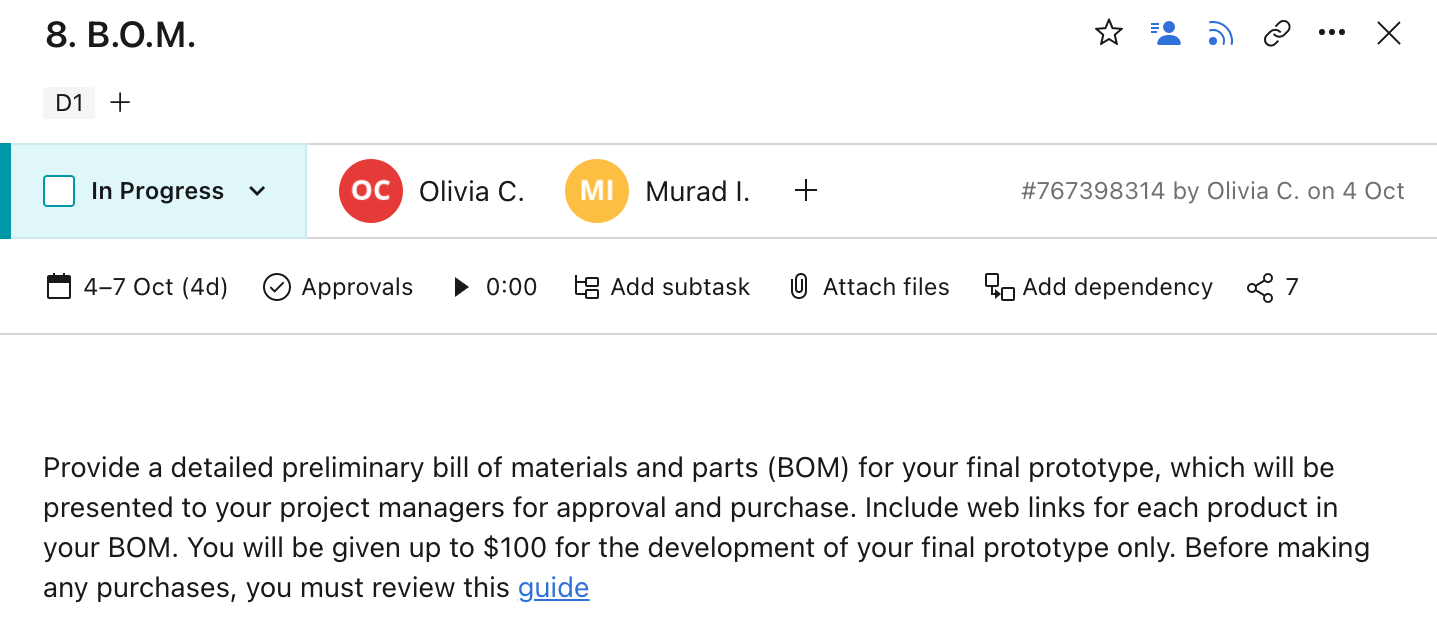


Figure 12 - Individual Task (Example D1-8)

## 6.2 Verify Dates

The time in which each task can be completed is decided based on the amount of work each task can be estimated to take based on the amount of research and writing that will be included in the final product. Most of these dates are not super strict, however, some tasks do hold dependencies and must be completed by a specific time in order for the rest of the project to move along. It is for this reason that it is highly encouraged to complete the assigned tasks by the due date given to them in Wrike.

## 6.3 Team Member’s Availability

When delegating tasks it is important to know that they can realistically be completed by the assigned individual on time without any issues. In order to do this, each team member is given the opportunity to ask for specific tasks to be assigned to and to ask to not be assigned to certain other tasks. This does not mean that they will necessarily be receiving the tasks they ask for, but if there is a conflict (such as availability during the assigned dates) it will be taken into consideration.

# CONCLUSION

The feedback received was used to create a successful prototype as well as a bill of materials(BOM) list. The priorities and design plan allowed for a clear description of what the client wants on the prototype as well as give a clear indication of what needs to be added or removed for further prototype development. The prototype test allowed the team to observe potential defects that could be improved upon to better the client’s needs. The team completed the ITP metrics which will provide helpful feedback to the team members. An updated project plan will keep the team on task and provide each team member with tasks that suit their expertise.