GNG2101

Design Project Progress Update

HCH1 Group A04

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List of Acronyms and Glossary

Table 1. Acronyms

|  |  |
| --- | --- |
| **Acronym** | **Definition** |
|  |  |
|  |  |
|  |  |
|  |  |

Table 2. Glossary

|  |  |  |
| --- | --- | --- |
| **Term** | **Acronym** | **Definition** |
| Design for X | DFX | Design for excellence. The X can refer to several different things a product can be designed for, such as manufacturing, sustainability, cost, reliability, etc. |
|  |  |  |
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# Introduction

Our project for this course is to design a high cup holder for a client living with cerebral palsy and spends their day in a wheelchair. Our client has offered us full creative control as long as we meet their required needs which were discussed in the previous deliverables but to briefly name a few, our focus is on a simple design, durable for everyday use and high adjustability. The purpose of this document is to organize the steps our group will take in reaching the final product through a series of deliverables where each will include work that highlights the progress we’ve made for a specific step. The document will feature a series of prototypes that will continue to be improved upon using client and peer feedback which will eventually allow us to present and demonstrate our final product. This document will also include additional economic and IP considerations.

# Prototype 1, Project Progress Presentation, Peer Feedback and Team Dynamics

## Prototype 1

One assumption we made from Project Deliverables B-D is that the locking levers and spring plungers we intended to use for the joints will be able to support the weight of the water bottle and the moment it would cause. By using locking joints and levers, the client would be able to adjust the arm with their limited mobility. This assumption is crucial as it forms the basis of the entire project, ensuring the cup holder can support the water bottle without spilling during public transit or while moving the wheelchair. Due to budgetary constraints, no physical prototype was built; instead, a 3D model was created in SolidWorks, which is permitted according to MakerRepo guidelines. This digital approach allowed us to observe how the mechanical range of motion of the levers and joints would work.

Building upon this, we decided to use an articulating arm instead of the original locking springs and levers with hard friction locks. Since this design does not provide a "hard lock," more thorough testing must be conducted. We also examined monitor stands and their respective benchmarks available in stores and online.

Our first prototype was constructed in SolidWorks, with dimensions roughly approximated. We wanted to modify the dimensions so the arm is roughly in a 20x20x20-inch box in front of the client, this is our desired range of motion. This prototype focuses on the functionality of the cup holder arm, which would be attached to the wheelchair using an articulated arm with three pivots. The following pictures are roughly to scale of the arm with the wooden section being the arm rest mounting.

Figure 1: 3 Way Pivot Arm with Dimensions Labelled

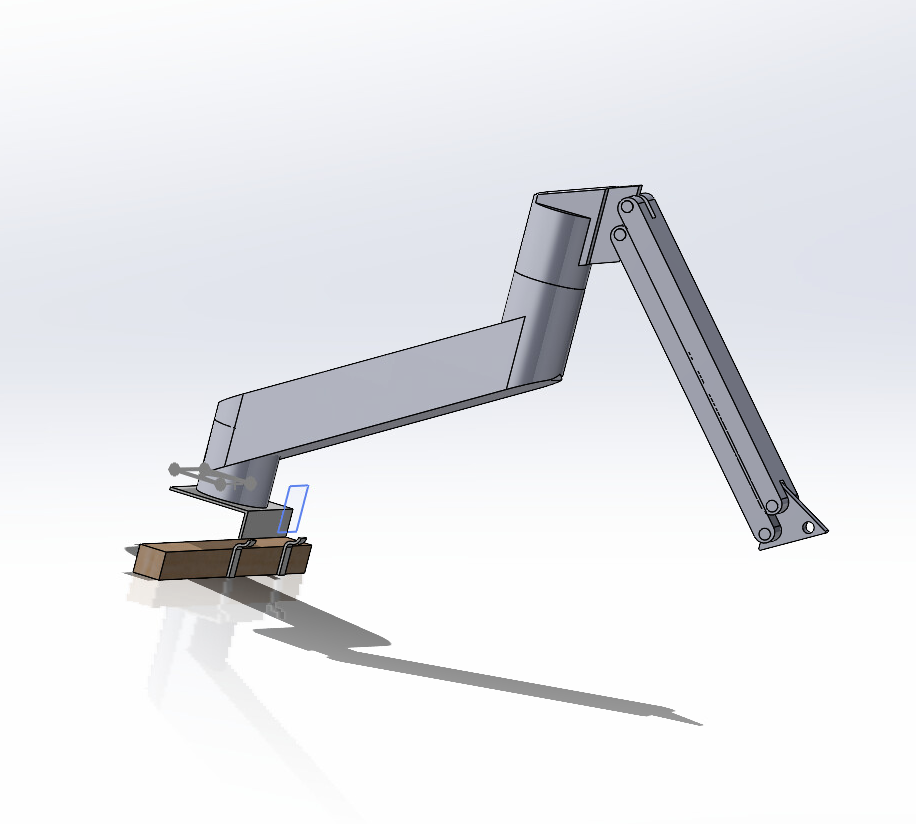


Figure 2: 3 Way Pivot Arm Showing Height Adjustability

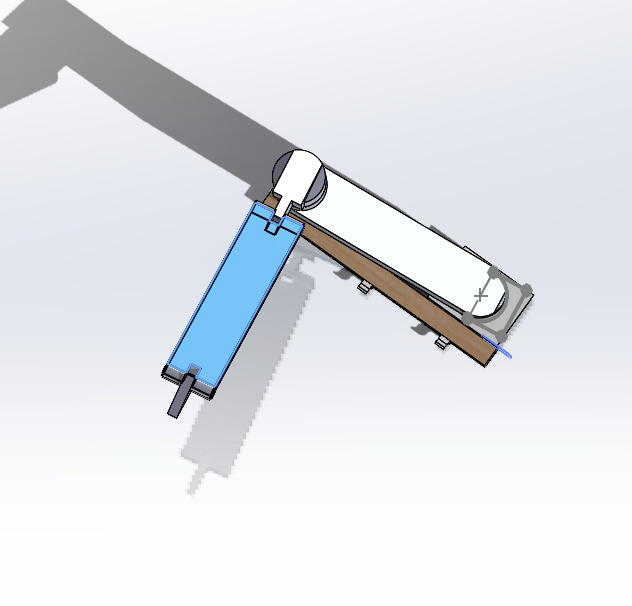


Figure 3: Top View of 3 Way Pivot Arm

In line with the DFX considerations from Deliverable B, this directly addresses the factors of functionality and reliability. Functionality is essential as it determines whether the cup holder can accommodate different cup or bottle sizes without sagging or failing under load. Reliability ensures that the mechanism will maintain its integrity over repeated uses and varying load conditions. To test this, we visited hardware stores such as Ikea and used lamps we had at home to get a general feel for how the articulating arm mechanism behaves under load.



Figure 4: Example of Lamp Arm to Be Used For Adjustability

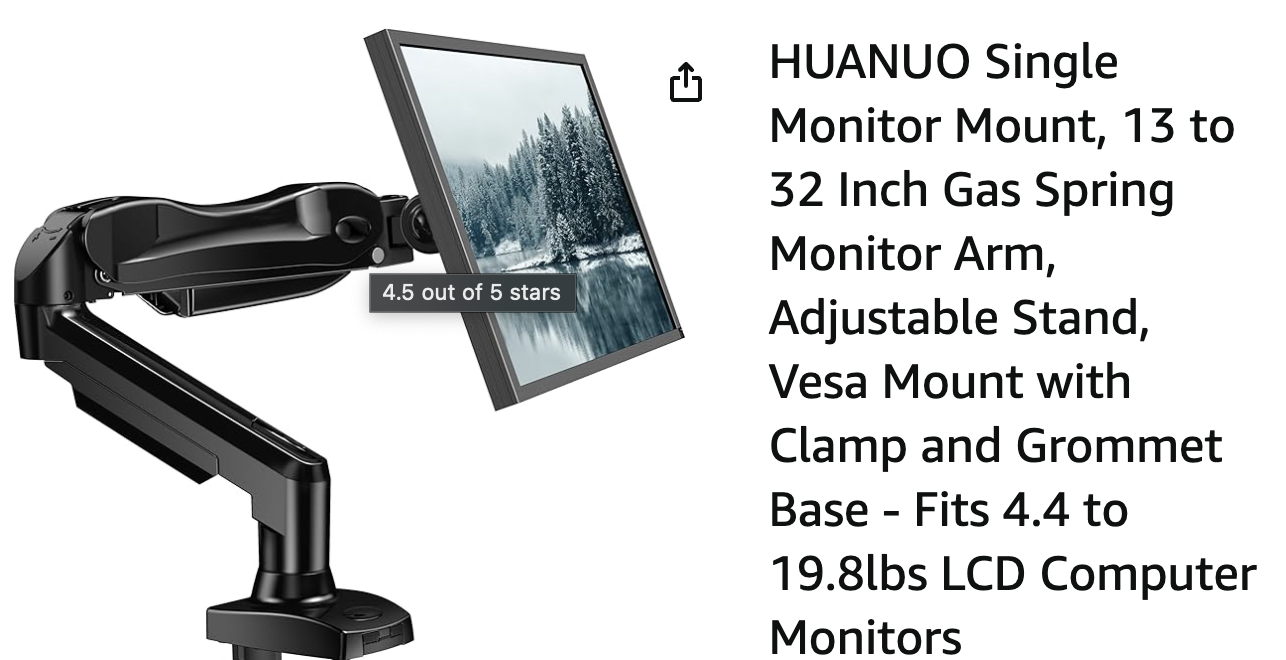


Figure 5: Example of Monitor Arm to Be Used For Adjustability

Load-bearing tests were not possible in SolidWorks because the specific washers and bolts were not available in the program. However, we were able to confirm the load by testing with real-life products.

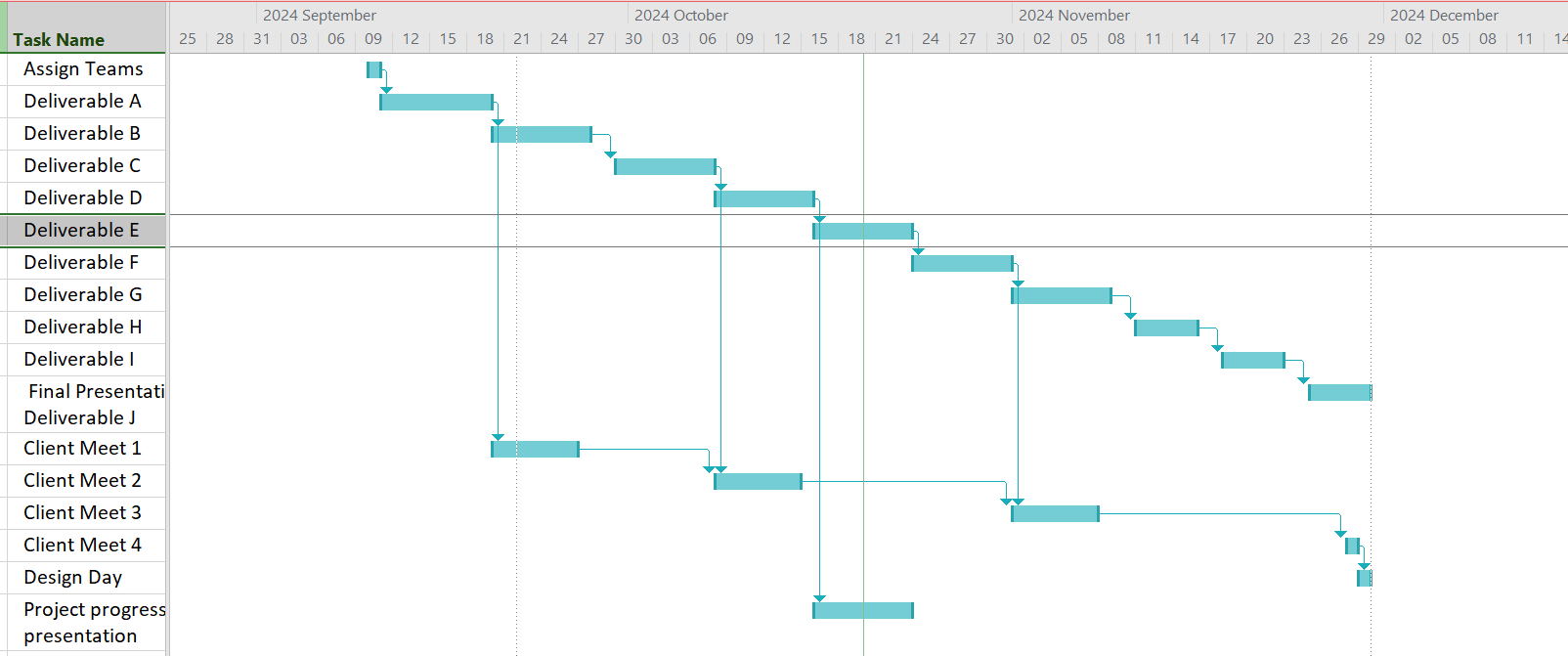
The DFX factors related to this assumption are usability and reliability. Usability encompasses how easily the arm adjusts and locks in place, while reliability addresses whether the gas spring and joints can consistently support the weight of a water bottle over time without degrading. If future prototypes are created, they will need to verify these assumptions through detailed physical testing or more complex simulations once specific parts are sourced.

As we continue with the project, the next iteration of the design will aim to refine the prototype by sourcing and incorporating detailed components, enabling a more thorough analysis and validation of these assumptions. Our final product concept involves utilizing a gas spring articulated arm rather than a purely friction joint arm for the cup holder design. We plan to repurpose a gas spring monitor stand and modify it to accommodate our cup holder. The arm we intend to use is rated to support up to 20 pounds, ensuring it can reliably handle the weight of various containers while providing the necessary adjustability for users with limited mobility. This approach not only enhances the functionality of the cup holder but also ensures durability and ease of use. The range of motion within the SolidWorks demonstration is similar to that of the actual monitor arm we are looking at for a potential candidate.

## Project Progress Presentation

<https://docs.google.com/presentation/d/1AQ6-Qq9zj6SUuKlZJssPWoUzBEF0AlHk1LRgzigSrW0/edit?usp=sharing>

## Project plan update



# Design Constraints and Prototype 2

## Design constraints

Manufacturability/Cost

One of the most major design constraints we encountered was needing to stay within the budget of $100. This meant that the design had to be extremely simple while meeting the demands of quality, durability, and usability. As such, the design would need to be modified to be as simple as possible and use as little parts as possible, since it would otherwise complicate the manufacturing process, raise costs, and potentially take more time to create than what we have.

Our existing design does not use many parts, which saves time and money, by utilizing third-party ready-made parts such as the arm and holding piece. We greatly reduced costs by focusing on making modifications to the existing model instead of building our product from raw materials that we may not fully use. However, many of our current parts do not functionally operate as intended and would not adequately meet our client’s needs. For example, the current cup-holder arm has shown an issue during our testing where the minimum weight support is not feasible with the weight of our cup holder, which would cause major inconveniences for the client since this meant that the arm could not be easily adjusted and locked. As such, our group is currently looking for alternative arms that use a different mechanism that may allow for smaller weight support. This method of prototyping ensures that we can create multiple prototypes after testing and feedback, each with radically different designs and not use excessive resources in the process.

## Prototype 2

1. Did not conduct 2nd client meet yet so this is unavailable.

2. The wheelchair cupholder prototype's three main unproven product assumptions are user acceptability, material affordability, and overall quality of life impact. Consumers want the design to be easy to use and helpful for handling drinks on their own, which is essential for improving everyday experiences. This presumption emphasizes the significance of attending to the particular needs of people with disabilities and is connected to the social DFX factor. To ensure the cupholder meets these needs, user testing will be crucial. This process will provide the design team and stakeholders with confidence in the product's usability and its ability to improve the user experience. Additionally, since we now employ free materials like lightweight PLA or PETG from 3D printing and laser-cut acrylic or plywood, production costs are not a big worry. By reducing waste and resource usage, these materials support sustainability.

Another essential principle is durability; the design must produce a sturdy cupholder that can endure repeated usage without breaking easily. By lowering material use over time, this longevity helps achieve sustainability objectives and adds to the environmental DFX factor. By encouraging convenience and independence, the cupholder will significantly enhance users' quality of life, highlighting the significance of considering those with impairments. A straw hole top will significantly improve usability by ensuring consumers can quickly receive beverages without spilling. Verifying the product's design, ensuring its success, and highlighting the interaction between environmental effects and social benefits throughout development are all made possible by testing these hypotheses. By methodically addressing these factors, we may improve the product to satisfy user needs while maintaining its functionality and sustainability.

3. Develop a second set of prototypes that will help you on your way to creating your final prototype and test the critical product assumptions along the way.

- The new prototype will be built using a microphone boom arm, selected for its ability to hold up to 3 kg of weight. This design choice marks a shift from using a monitor arm, which was originally considered but ultimately set aside due to its higher cost and bulkier structure. The microphone arm offers a lighter, more affordable alternative while performing similar functions in terms of flexibility and adjustability.

This prototype details the chosen components for both the cupholder and mounting mechanisms. For the cupholder, we’re exploring two options: creating a custom 3D model to print in the university makerspace, which would be a budget-friendly solution, or alternatively, shaping aluminum sheets into the desired holder form, also using makerspace facilities. The aluminum approach provides additional durability, while the 3D-printed option allows for precise customization to fit the cup securely. Our aim is to ensure that the cupholder weighs less than 1000-750g ideally.

The mounting mechanism will consist of a wooden bar placed under the wheelchair's armrest. This bar will be fastened with strap buckles to allow easy attachment and detachment, enhancing convenience for the user. To protect the armrest surface, the wood will be lined with a rubber padding layer, which also prevents slippage and provides a stable base for the cupholder. Together, these components are designed for a balance of stability, ease of use, and practicality, ensuring a secure and functional cupholder for the user.

Weight wise we want to have 1kg water + 750g holder + Cup weight < 3kg

4.

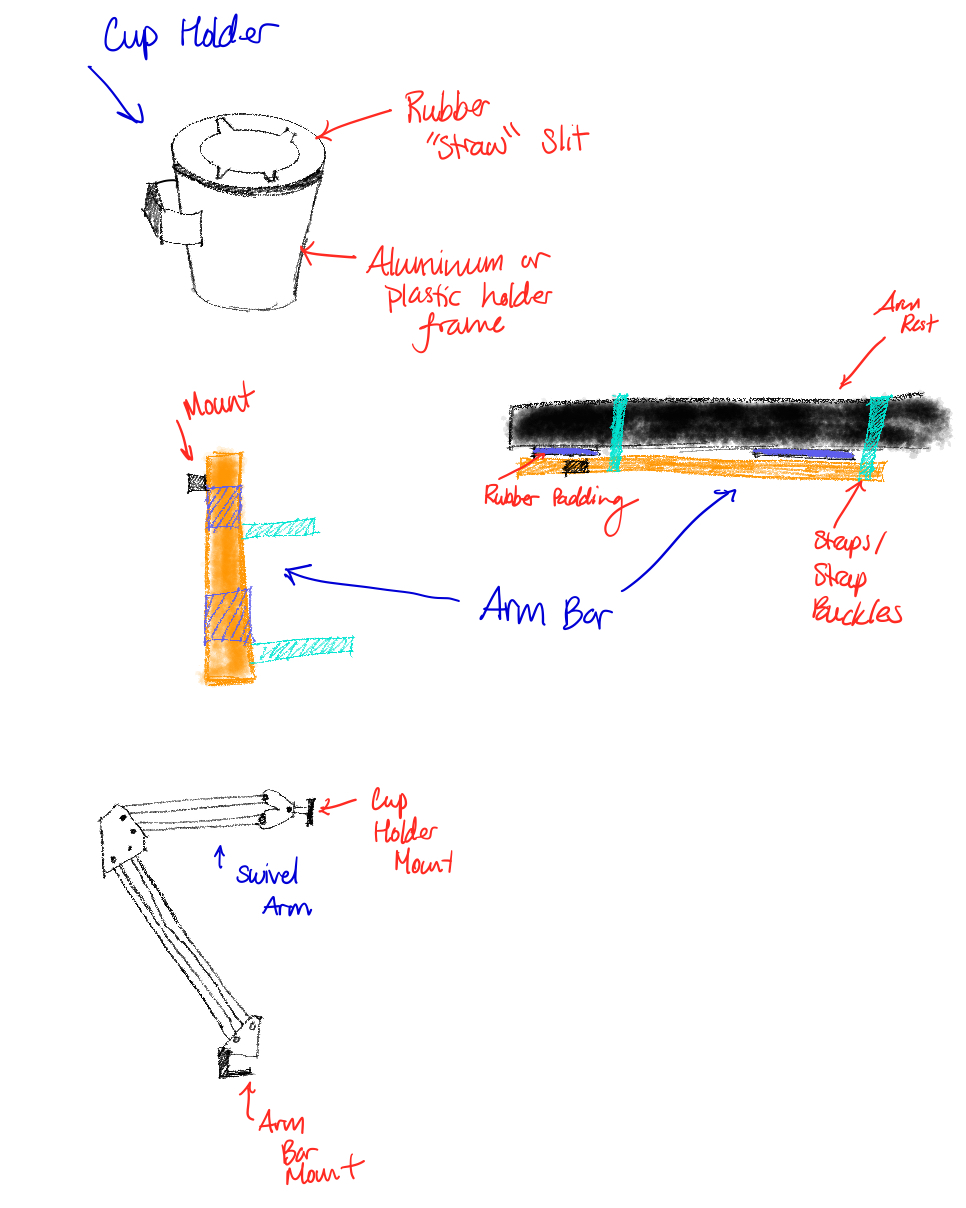


Figure X: Preliminary Sketch of Prototype 2



Figure X: Boom arm that will be used

6.

1. Overview and Objective of the Project

* Objective: Create a high cup holder that is easily accessible for the client.
* Description: The device should be a semi-removable, sturdy clamp-on cup holder that is readily available, adjustable, and lockable. It must be robust enough for use during public transit (OC Transpo) and have a clean black appearance.

1. Design of Prototype and Functionality

* Visual/Physical Demonstration: Show prototype or concept drawing of how the holder will attach to the right side of the wheelchair and how the clamp mechanism works.
* Swivel Mechanism: Show how the holder swivels in when required and how it tucks away safely when not in use.
* Adjustability and Positioning: Highlight how the position of the cup holder can be adjusted for easy reach and safety.

1. Material Choices

* Durability and Functionality: The kind of material to be used is metal for the arm and clamp and rubber on the lining where the cup holders go. This represents strength and shall durability, which will hold the cups in place.
* Sturdiness: They will help keep the cup holder stable to sustain bumpy rides on public transportation.

1. Color and Aesthetic

* Uniform Design: Verify the client's preference for having the cup holder black or uniformly colored in order to match the wheelchair frame. Explain how the design chosen puts functionality first with a clean, minimal look.

1. Budget

* The budget of the project and at a maximum of $100. From this projection, We will try to find the cost to be cheaper than 100 if possible.

Information to Gather from the Client

1. Comments on the Prototype

* Does the prototype or design concept meet the client's needs for reachability, comfort, and ease of use?
* Is the swivel mechanism smooth and easy to operate with only the right arm?

1. Considerations of Use on a Daily Basis

* How well does the design meet the daily routine considerations of the client, especially in using public transport such as OC Transpo?
* Is there anything specific concerning issues or suggestions for better enhancement to the design in accommodating the activities of the client or limitations in their mobility?

1. Additional Modifications

* Are there concerns about the height of the cup holder, the range of swivel, or the manner in which it locks into place?
* Is the mechanism for locking/unlocking easy for the client to manage with limited mobility in one hand?

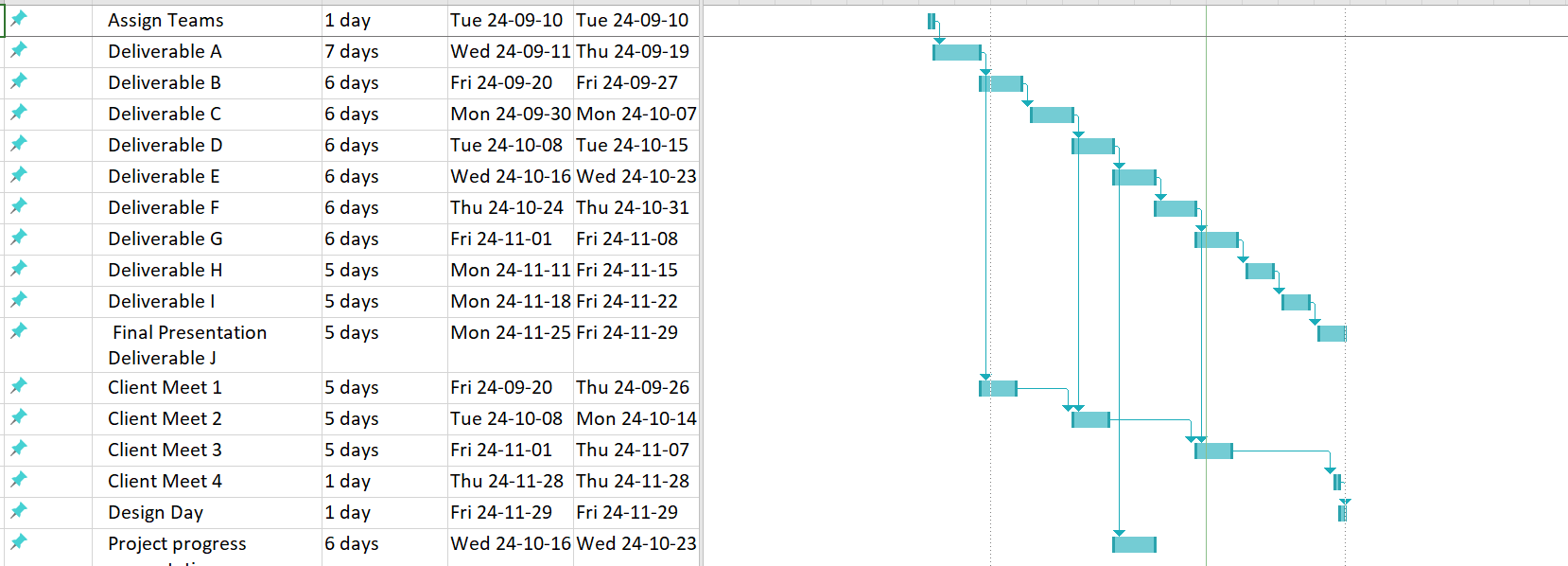
1. Aesthetic Considerations

* Is the black functional design according to the client's expectations, or are there any preferences regarding minor adjustments in the design?

1. Durability Long Term

* Has the client developed any apprehension related to materials on durability, considering regular or heavy usage?
* Was there any expectation of wear and tear that needed to be taken care of before freezing the design?

## Project plan update



# Economic and IP Considerations

## Economics report

[Cost percentages are just references from Economics Assignment 1 (delete this before submission]

Cost classifications:

Rent, marketing, electricity, machinery, overhead, production materials, salaries,

* $2.8% cost for Marketing Campaigns - Expense, Variable, Indirect
* $14% cost for Electricity - Expense, Fixed, Indirect
* $33.6% cost for Salaries - Labour, Variable, Indirect/both
* $42% cost for Production Materials - Material, Variable, Direct
* $2.8% cost for Overhead - Expense, Fixed, Indirect
* $1.4% cost for Depreciation - Expense, Semi-Variable, Indirect
* $3.3% cost for Rent - Expense, Fixed, Indirect

Cost of one high cup holder: $40

Price of one high cup holder: $85

Estimate of 20% anual increase.

|  |  |  |  |
| --- | --- | --- | --- |
| **HCH Income Statement** | **Year 1** | **Year 2** | **Year 3** |
| **Revenue** |  |  |  |
| High cup holders | $720,000 | $1,440,000 | $1,760,000 |
| Cost of Goods Sold | $360,000 | $720,000 | $880,000 |
| **Gross Profit** | $360,000 | $720,000 | $880,000 |
|  |  |  |  |
| **Operating Expenses** |  |  |  |
| Marketing Campaigns | $30,000 | $30,000 | $25,000 |
| Electricity | $80,000 | $95,000 | $120,000 |
| Salaries | $270,000 | $290,000 | $300,000 |
| Overhead | $10,000 | $12,000 | $12,000 |
| Rent | $30,000 | $35,000 | $40,000 |
| Depreciation | $4,000 | $11,000 | $16,000 |
| Total Operating Expenses | $424,000 | $473,000 | $512,000 |
| **Net Operating Income** | -$64,000 | $247,000 | $368,000 |

1. **Assumptions:**

* The cost classifications costs are highly dependent on how much revenue our projected future company and how much our company can afford. In which case, it is easier to make an assumption that we have lots of money to use and will use an arbitrary cost of $500,000 (or percentage based split of costs).
* The production cost of one high cup holder is $40
* The selling price of one high cup holder is $80, because this [market example](https://www.amazon.ca/Mobility-Holder-Portable-Attachment-Adjustable/dp/B0822YSSRN/ref=sr_1_10?dib=eyJ2IjoiMSJ9.RygRvD8pJ_GR1QCojY9HAJcE7Mru18Wo8Hgfbvs4VP-3x3Ww9r052rHFIQWV8dSiuVMeTdGlJyXdjovFknRgdTwGCCYj54b1OYDmFVZ5EfAegMP06PRtGnyoPgPZizV_Shv-wp3k6ZNJFP6-WbNuyJm2YMmVABmWehHgxwtcGasOGXocJKBhZ3n35VVReoMnAkih6zpKiNPtyOEzXJhcpnNO4oAqVnjMZYCCfG5w3Sgw1mORCIOKgYhrIY5IlDMG5cjQIJXP_ISsgbyQTYwSWq_SuOXlPzBcNKLdx47cs40.2OTkhCLlwdgBd47mVsdZwJr8ExdH3G5ebXbORnSOIJs&dib_tag=se&hvadid=604714631686&hvdev=c&hvlocphy=9194676&hvnetw=g&hvqmt=e&hvrand=3216081286594012110&hvtargid=kwd-302305871243&hydadcr=21120_13374302&keywords=wheelchair+cup+holder&qid=1731898566&sr=8-10) is around $30, and our product includes a moving arm
* That we had 9,000 sales (year 1), 18,000 sales (year 2), 22,000 sales (year 3)
* Produced 9,000 units (year 1), 18,000 units (year 2), 22,000 units (year 3)

## Intellectual property report

US5597148A is a patent covering the secure mounting system for wheelchairs focusing on trays and holders. This can impact us since we use a clamp paired with buckles to latch onto the armrest while this uses a unique clamping mechanism that fits onto the armrest. Legally, you must ensure that your cup holder's adjustable mounting system does not infringe on this patent. We must avoid mimicking and making anything too similar.

**US6390426B1** is a patent for an adjustable accessory mounting system for wheelchairs, which includes a telescoping bar and adjustable mounts to attach various accessories like trays. This system is relevant to us since our cup holder uses a clamp with an articulating arm to mount to the wheelchair armrest. The clamp design and adjustable arm mechanism in this patent could impact our product if there is overlap in how the mounting system is secured or adjusted. We avoided using a telescopic arm so we do not have to worry about the arm mechanism itself.

## Project plan update

A screenshot of a computer

Description automatically generated

# Design Day Pitch and Final Prototype Evaluation

Write your design day pitch and plan your prototype demo.

ENTIRE SCRIPT AT BOTTOM

1. Explain why the problem is important (“So What?”). This will require some research and rehearsal. You need to be very crisp and clear about what problem you have solved and what work you have done.

2. Explain the basic user requirements and why solving the problem is important (“Who Cares?”), as well as current solutions and alternatives.

3. Explain the differentiation in your design or the key aspects that make your final prototype better than other solutions on the market (“Why you?”).

4. Provide a demonstration of your functional final prototype in action

ENTIRE SCRIPT STARTS HERE:  
**Script: High Cup Holder for Wheelchair Users**

[Opening]

Hi Judges, I am Jordon, these are my group memebers, Omar, Jonathion, Demetri, and Matthew, we are the SipSetters. Today, I’m excited to present our **High Cup Holder**—our solution designed to empower wheelchair users, particularly individuals with cerebral palsy or limited arm mobility. Let me walk you through the problem, our solution, and why it matters.

Our client tasked us to help him out and make a cup holder that holds his drink at a high and convenient height for his limited arm mobility.

He described his experience as a wheelchair user that securely holding or accessing a cup can be a frustrating challenge. Spills, reliance on caregivers, and ill-fitting or unstable cup holders are common problems that reduce independence and quality of life. A little bit of research show that over **17 million people globally live with cerebral palsy**, and many rely on mobility aids and assistants. Despite a growing market for adaptive devices, there’s a gap in affordable, user-friendly designs that truly meet these users’ needs, which our client describes as costing hundreds maybe thousands of dollars. Our High Cup Holder addresses this issue with a focus on convenience, adjustability, and ease of use.

We designed our product around the needs of real users. To be effective, the cup holder must:

1. **Be durable for rough use on OC Transpo and withstand hits and knocks**
2. **No damage to the chair**
3. **Offer secure mounting** near the head
4. **Easy to use and to mount/dismount from the chair**

**[Matthew Starts]**

Who benefits? Both wheelchair users and their caregivers. This design promotes independence, reduces frustrations, and minimizes hazards like spills on electronics or clothing. Current alternatives, such as off-the-shelf cup holders, often lack adaptability and durability, while DIY modifications rarely provide the safety and stability required.

Who does this benefit, both the wheelchair user and the caregiver alike. This desgin promotes the independence of the client and overall improves their quality of life and improves

[Why Our Solution Stands Out: “Why You?”]

Our High Cup Holder stands apart in several ways:

* **Adjustable Articulating Arm:** This feature allows the holder to be repositioned for optimal comfort and access.
* **Clamp Mounting System:** The secure clamp fits a variety of wheelchair armrests without permanent modifications.
* **Universal Cup Fit:** A narrowing cup base ensures compatibility with different cup sizes and styles.
* **Robust Materials:** By using lightweight wood or metal, the design is both durable and easy to handle.
* **Cost-Effective Design:** Unlike premium solutions, our holder combines affordability with superior functionality.

[Demonstration]

Now, let’s see the prototype in action:

* First, the clamp attaches securely to a wheelchair armrest, showing its adaptability to different sizes.
* Next, the articulating arm is adjusted to position the holder as needed.
* Finally, we place cups of varying sizes in the holder, secured by the rubber strap, and demonstrate stability—even on uneven surfaces.

[Closing]

With this design, we’re tackling a simple yet impactful problem head-on, giving users more independence and control in their daily lives. Thank you for your time, and I’m happy to answer any questions!

Timed Script : 2m 15s

# Video and User Manual

## Video pitch

Add link to video.

## User manual

See separate template for the user manual. Do not write the content here.

# Conclusions

Summarize your lessons learned and your work related to your project. Discuss any outstanding issues or implications for the project.

# Bibliography

Insert your list of references here.