GNG2101

Design Project Progress Update

COZY CAPYBARAS: B1.4

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Critical Assumptions, Tests and DFXs

1. The PVC pipes used in our design are compatible with our design.

   To make the prototype within our budget, we will be using PVC pipes that were found within the Makerspace resources available to us. Our assumption is that the pipes that we find for our arm prototype will be compatible with the rest of our subsystems. Furthermore, since there are many different types of PVC, we assume that the glue we put on the joints to secure the structure will work for different types of PVC.

   To test this assumption, we plan to find spare components of PVC pipes and check for their compatibility. The DFX factor that this test relates to is "Design for Reliability" as having a strong support system of pipes makes the design reliable due to its strength and resistance.

2. The bed railing will be able to support the designed product.

   During our client meeting, we noticed that the bed railing was slightly fragile, leading to the possibility of it collapsing under the pressure from the mount.

   To test if the railing can withstand the weight of the mount, we plan to directly test our prototype during our next client meeting to test if its functions for its intended purpose. The DFX factor that this test relates to is "Design for Safety" since if the bed railing cannot support the product, it could lead to the mount collapsing onto the client.

3. The U-bolts used on the clamp can be tightened.

   As shown in our initial prototype of the clamp subsystem, we plan to use U-bolts to tighten the clamp on the bed rail. However, the above assumption is only valid if the U-bolts are long enough to touch both sides of the design before tightening around the PVC pipe.

   To test for this assumption, the physical U-bolts are needed. Once we have access to those bolts, we will place them through the clamps to check for their length. In the meantime, U-bolts can be 3D printed as placeholders. The DFX factor that this test relates to is "Design for Adjustability" as the goal of the U-bolts is to tighten the clamp and thereby, make it adjustable for the client.

4. The flex seal used on the clamp will be thick enough and will not come off.

   If the U-bolts cannot be properly tightened around the PVC pipe, we plan to put a flex seal to rubberize the clamp. However, this contingency plan comes with two key assumptions. Firstly, we assume that the flex seal will have a thick enough layer. Secondly, we assume that the flex seal will not come off even if the clamp is overused.

   To test these assumptions, we can 3D print another clamp like our prototype and coat it with flex seal. Then, we can use the clamp and check to see if there is any damage resulting from using it. The DFX factor that this test relates to is “Design for Usability” since the functioning of the flex seal will impact the ability to effectively use the clamp.

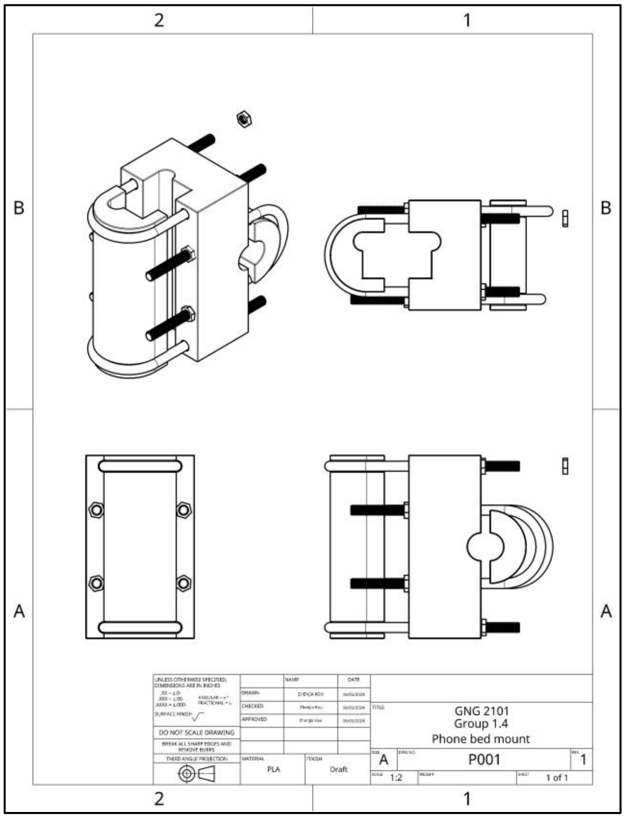
5. Measurements taken for the bed mount will be applicable to both the client and other users.

   The initial measurements of the bed were taken to build the prototype with respect to our client’s dimensions. However, we are assuming that these measurements will be applicable to a large percentage of the population.

   To test this assumption, we plan to introduce this device to other people and see if they can use it properly as well. If most people can properly use the device, it will prove that the device is compatible for other users as well. The DFX factor that this test relates to is “Design for Compatibility”. This DFX was not one of the ones mentioned under deliverable B; however, our group gives it equal importance as the other five DFXs listed.

First Prototype(s)

Subsystem #1: Clamp



Type of Prototype: Focused and Physical

The above prototype P001 is the first revision of subsystem #1, which is the clamp. Currently, the problem we are facing with this prototype is the amount of stability this clamp can support. Subsystem #1, which is our arm, has a relatively good design. That is why this deliverable has more emphasis placed on the clamp subsystem of the design.

Since the bed’s armrest has an unusual shape, it was difficult to find a commercial part designed to clamp onto the rail efficiently and effectively. Hence, we decided to design our own part on SolidWorks to improve the stability of the clamp. Thanks to Tetris Group's bed rail model, we can make a firm, maybe slightly over-engineered PVC pipe holder for the application.

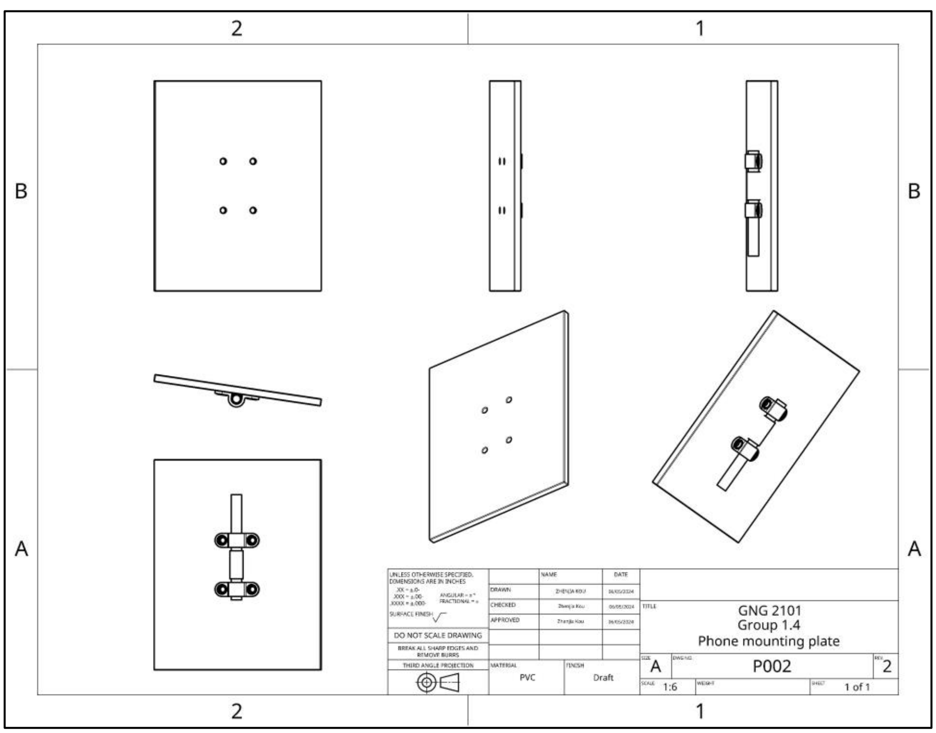
This subsystem includes four U-bolts, two of each pair, that structurally support the clamps. The bolts apply clamping force onto the rail and pipe, with the 3D-printed parts helping to distribute the force. Due to its low price and wide availability, we used PLA as our filament for the 3D-printed parts. This prototype focuses on testing three key factors. The first one is to determine if this shape can hold the main PVC pipe in place while applying a strong force in the perpendicular direction of the U-bolt. The second one is to find out if the design demotion is efficient and correct. The last step is to test the different structural strengths with different percentages of print infill.

Subsystem #2: Arm

Type of Prototype: Focused and Physical

Parts for this subsystem were found in the Makerspace. The entire component is made of PVC pipes. This subsystem is the connection between the clamp and the mount. It goes above the client from one side of the bed railing to the other and the client should be able to push it out of the way when not in use.

Subsystem #3: Mount



Type of Prototype:

Focused and Analytical

The above prototype P002 is the phone mount that will be attached to the main body of pipes. For the initial prototype of this subsystem, we do not have a physical prototype since this is the same setup that the client is currently using. Since the client seems relatively happy with the current design, we decided to keep it as our initial prototype and add features to it, if time permits.

The design is simple, with two commercially available pipe holders to clamp on the main body. The pipe in the middle of the two pipes is slightly wider than the holder dimension, so the mounting surface cannot slip out, giving a small amount of rotational freedom. When we test the prototype later, we will mainly focus on its ease of use, the dimension of the mounting surface, and its integration with our body design.

Prototype Testing

In this step, we aim to test out our prototypes, analyze them and evaluate their performance compared to the target specifications that we established in deliverable C. Below are the target specifications from deliverable C.

- Flexible Arm
- Strong and Long Arm
- Adjustable Mount
- Tight phone holder using Velcro
- Secure attachment to right-side bed rail
- Easy to install/uninstall
- Easy to swing
- Mount-tightening feature
- Lightweight

These target specifications have not evolved since deliverable C. The testing results are documented in the tabular form that shows the expected values versus the actual values (results). For each target specification, the subsystems of prototype I are tested using an applicable test strategy. From there, depending on the result obtained, we can establish if the result of the prototype testing is a pass or fail. If it is a pass, we can maintain the design for future prototypes. If it is a failure, the design requires some more thinking to meet the target specifications and pass the test set in place for the prototype.

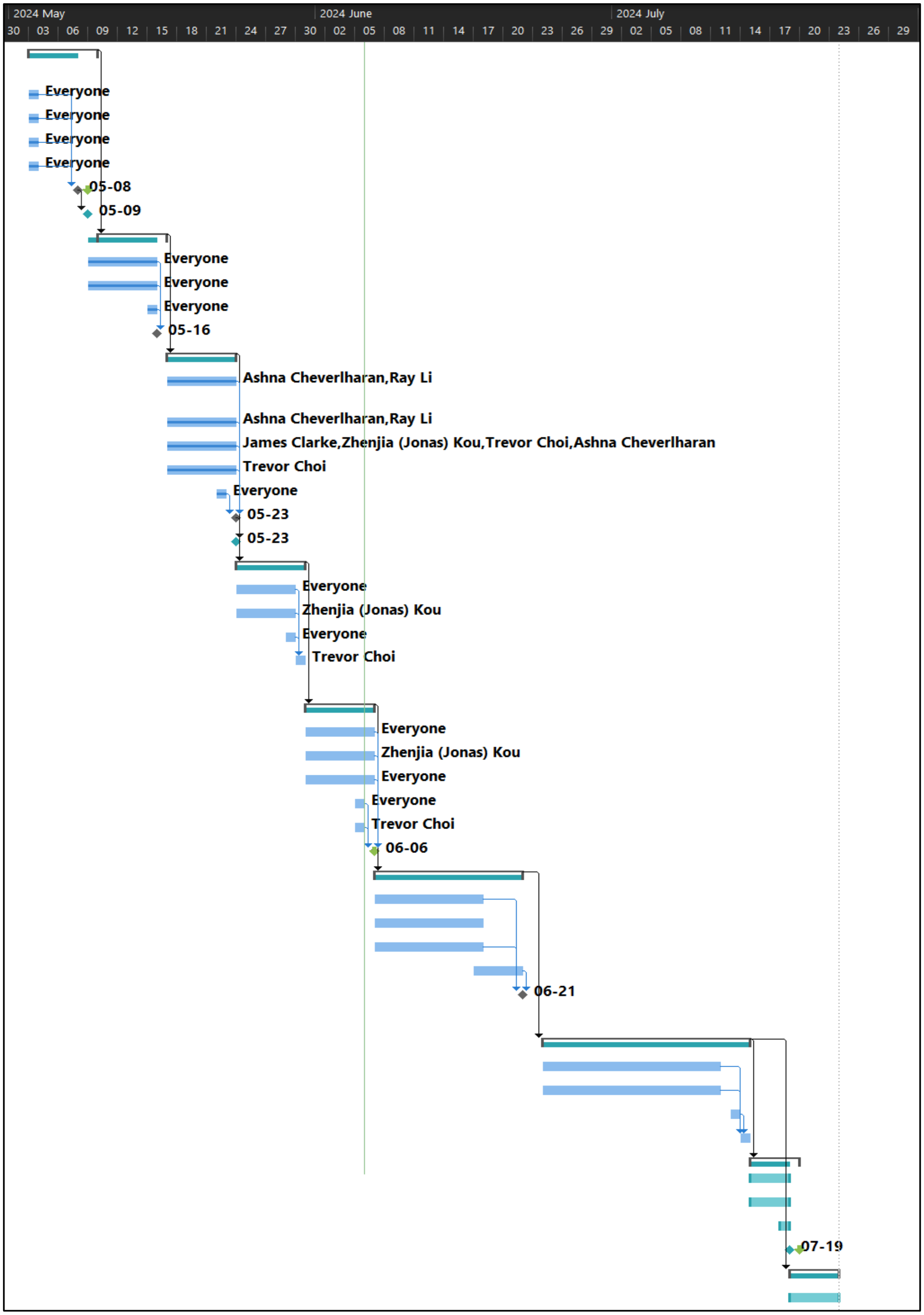
For the table illustrated below, a couple of target specifications from deliverable C were taken and test strategy were put into place to evaluate them. If results from a test could not be obtained due to the lack of prototype fidelity, it is notes as N/A.

Table 1: Prototype I Test

Target Specifications	Prototype I	Test Strategy	Results
Easy to install and uninstall	Focusing on clamp subassembly	If time taken to install/uninstall mount is no more than 5 seconds, test is passed	N/A because clamp is not fully assembled yet
Mount-tightening feature	Focusing on clamp subassembly	Tighten clamp with U-bolts and check for amount of movement resulting	N/A because no U-bolts or assembled clamp yet
Easy to swing	Focusing on mount and arm subassemblies	If the weight of “push away” force is less than 1.5kg, then test is passed	Pass
Tight phone holder using Velcro	Focusing on mount subassembly	If the Velcro can hold the phone in place, the test is based	N/A because no physical model of mount yet
Flexible Arm	Focusing on arm subassembly	If the number of axes of freedom is three, then test is passed	Pass
Adjustable Mount	Focusing on mount subassembly	If the degree of tilting movement is around 5 degrees, then test is passed	N/A because no physical model of mount yet

3 Project Progress Presentation

https://docs.google.com/presentation/d/16v-G45KdW0so45cv7LqUab-IEwdx-T2zDUHEQ2b3bHU/edit?usp=sharing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4 Design Constraints and Prototype 2

Non-Functional Design Constraints

1. Red Aesthetics

   The client was very insistent on the fact that our design should include the colour red. This is a factor that we can control by buying red material or even using red thread when 3D printing. Therefore, given the choice, we all collectively agreed that we should make our design red. However, sometimes this factor can impose as a constraint as certain material simply only exists in certain colour. In that case, we would need to make an exception to this constraint or search for alternative solutions that include the colour red.

2. Budget

   For our project, the budget assigned was $50. Having a tight budget imposes a major constraint on us as it led and continues to lead us to products of cheaper quality. Our ability to get creative with our design is limited due to the lack of resources and supplies. When deciding which supplies to use, we always must keep in mind that we have a budget and that we also have minimal control over material costs. For example, in our design, we decided to incorporate PVC pipes, mainly because PVC material from previous projects were already available for us to use in the MakerSpace. Therefore, we were able to cut down the cost of buying the PVC at the current market price, which is around $30/10ft.

Abiding by Constraints

1. Red Aesthetics

   To ensure that we maintain the colour theme of red, we will try to use the colour red in all our parts. For instance, when it comes to 3D printed parts, we can use red threading. Furthermore, if we have enough time, we can paint other materials, such as wood, in the colour of red. As mentioned above, there may be exceptions where parts only come in generic colours. In that case, we may need to make exceptions.

2. Budget

   To ensure that we follow our budget of under $50, naturally we were in search of the cheapest products in the market, without sacrificing the quality of the product.

Furthermore, we took advantage of the resources available to us at the MakerSpace to cut unnecessary costs. If we already had access to certain materials at school, there was no point in trying to find a similar product online. We also tried our best to avoid unnecessary materials that would result in additional costs.

Proof of Effectiveness of Constraints

1. Red Aesthetics

   Our design is comprised of three parts - the clamp, the pipes and the mount. If we were to 3D print our clamp red, 1/3 of our design would officially be red. Furthermore, the pipes that we plan on using are white. However, if we painted the pipes red as well, 2/3 of our complete design would be red. Finally, the physical mount could also be colored red depending on what material the mount is made of (plastic, wood etc.). As a team, our goal was to have at least 70% of the design in the colour red. Given the progress so far and the plan in place, this could be a possibility.

2. Budget

   In terms of the pipes, by using the pipes found in the MakerSpace, we are cutting down the costs tremendously. In the current market, a 5-foot-long piece of PVC piping costs $24.56. By using the ones at MakerSpace, we are saving $25 from our $50 budget. If we were to buy new pipes with current market prices, 50% of our budget would go towards one singular component. This would pose as a constraint when searching for other products, as our budget would only have $25 left.

Detailed Design Updates

Based on the given constraints, assume that our detailed design was updated to incorporate the colour red in various parts of the design. Some of the materials, for instance, the piping, can be indicated as found in the MakerSpace.

New Client Feedback and Testing Results

In terms of a new client feedback, we gained more clarity regarding how our design should look and its mechanisms. We received a lot of feedback from our client and are now aware of what needs to be changed or improved in our design. We also took measurements of the bed and the railing, as our initial measurements were not accurate enough.

Upon presenting our prototype, overall, the client had a positive reaction. The client was pleased to hear that we planned on using PVC for the piping around the bed. However, she told us that it would be best to avoid using gooseneck for the mount as the client feels that it is too stiff and had some bad experiences previously. The client also encouraged us to use Velcro for the bed mount, as it would ensure that the bed mount attachment remains stable. We were also given permission to use the bed's board if needed. The client appreciated the emphasis placed on the level of adjustability and mobility.

In terms of testing results, the prototype II testing table below summarizes the key tests that were done or remain to be completed, to ensure that our prototype II can become a complete, physical prototype. To improve the design further, the client emphasized the need to ensure that the mount moves horizontally. Also, the client suggested we find ways to securely tighten the mount, so that it does not fall when setting up as well as ensuring that the mount is easily removable. We will keep this feedback in mind when building our next prototypes.

Untested Critical Product Assumptions

There are mainly two critical product assumptions that have not been tested yet.

1. **The flex seal used on the clamp is thick enough and will not come off.**

   If the U-bolts cannot be properly tightened around the PVC pipe, we plan to put a flex seal to rubberize the clamp. However, this contingency plan comes with two key assumptions. Firstly, we assume that the flex seal will have a thick enough layer. Secondly, we assume that the flex seal will not come off even if the clamp is overused.

   To test these assumptions, we need to 3D print another clamp that is identical to our current prototype and coat it with flex seal. Then we can use the clamp and check to see if there is any damage resulting from using it. This assumption has not been tested yet due to lack of time and focus on other aspects of the project.

The DFX factor that this test relates to is “Design for Usability” since the functioning of the flex seal will impact the overall ability of the clamp to be used effectively.

2. **Measurements taken for the bed mount are applicable to both the client and other users.**

The initial measurements of the bed were taken to build the prototype with respect to our client’s dimensions. However, we are assuming that these measurements will be applicable to a large percentage of the population.

To test this assumption, we plan to introduce this device to other people and see if they can use it properly as well. If most people can properly use the device, it will prove that the device is compatible for other users as well. This assumption has not been tested yet since it can only be tested once the project itself is complete.

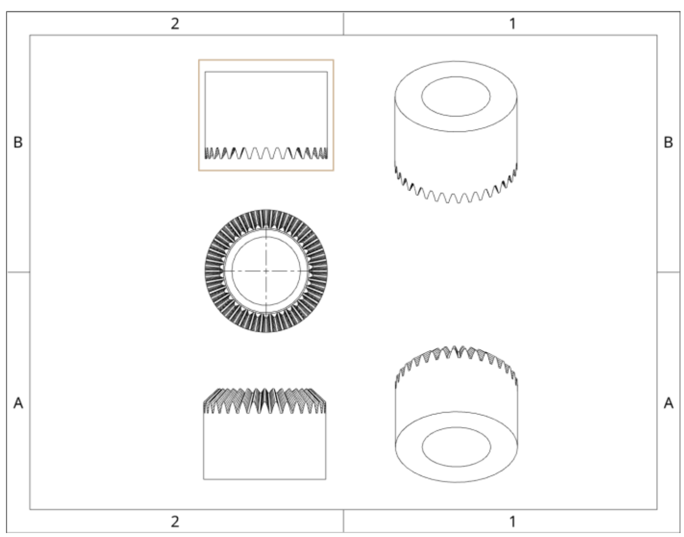
The DFX factor that this test relates to is “Design for Compatibility”. This DFX was not one of the ones mentioned under deliverable B; however, our group gives it equal importance as the other five DFXs listed.

Prototype II

Before our last client meeting, the original design focused on using the right side of the rail to secure the mounting machine. As illustrated in the figure above, we designed a clamping system that would be able to hold onto the rail simultaneously. This allows it to be removed from the main body easily. The figure above depicts our second prototype of the entire assembly.

After talking to the client and her caretakers, we realized that the caretaker needed space on the right side of the bed to help move the client in and out of bed. Therefore, our clamping mechanism may be in the way. Upon further conversation, we were able to think of an idea to solve this conflict. The front side of the bed had plenty of space for us to install a mounting mechanism.

Unfortunately, this idea led to more problems to be solved. The main concern was the rotation of the main body. The clamp from our second prototype was in the parallel direction of force applied when the client used her phone. However, if the clap were moved to the front of the bed, it would mean that the main body is perpendicular to the force during usage. This means we would need a method to stop the rotation of the main body so that it would not complicate our current design and not increase the difficulty of usage.



Therefore, we decided that the best course of action would be to add a gearing system with the clamp. Illustrations of the gear as well as its place within the rest of the assembly is illustrated above. When the main body is dropped into the clamp, the gear mounted on the main body will lock into another gear inside the clamp to stop the rotation. One benefit that comes with this design is the ability of the client to be in different positions in bed. With the drop in gearing system, we can adjust the angle of the main body to counter the movement.

Prototype Testing

The table below illustrates the testing methods done or are yet to be done to ensure that our prototypes function efficiently. Note that new prototype tests regarding prototype II were added underneath the previous prototype tests for prototype I. Some of the test strategies are yet to be tested depending on the progress of the specific prototype.

Table 2: Prototype II Test

Target Specifications	Prototype II	Test Strategy	Metrics	Results
Easy to install and uninstall	Focusing on clamp subassembly	Completely uninstall and reinstall every part of the clamp	Reinstall time less than 15 seconds	N/A because the clamp is not fully assembled yet
Easy to swing	Focusing on mount and arm subassemblies	Use a push force scale to measure the force required until the main body starts to swing.	The force required to swing is less than 1kg	Pass
Tight phone holder using Velcro	Focusing on mount subassembly	If the Velcro can hold the phone in place, shake the holder in all directions at the desired speed	The phone will not move under 5kg of force applied in all directions	N/A because there is no physical model of the mount yet
Flexible Arm	Focusing on arm subassembly	Simulate the normal usage of the phone holder to see if the arm will only move in the intended direction.	Only rotation direction will push away	Pass

Adjustable Mount	Focusing on mount subassembly	Push the mount in the normal use direction and use the lever to measure.	The degree of tile is less than 5 degrees	N/A due to no physical model of the mount yet
Secure Mechanism for Clamp Tightening	Focusing on clamp subassembly	If the U-bolt cut-out is the same size as the U-bolt, then the printed part size is correct, and the test is passed.	Gapes between parts is less than 2mm	Pass
Amount of friction between joints	Focusing on arm subassembly	After all pipes are assembled, we will twist the body to test how much movement with only friction.	Body movement less than 5cm from mount to clamp	Did not pass Glue is required
Compatible Pipe Hole Size	Focusing on clamp subassembly	If the pipe fits perfectly into the pipe hole of the clamp, then the test is passed.	N/A	Did not pass The hold needs to be 1/8’ bigger
Lightweight System	Focusing on the entire assembly	Weight the system on a scall to test the weight	All assemble systems are less than 2kg	N/A because the assembly is not fully built yet
Appropriate Shape for Clamp Design	Focusing on the clamp assembly	If the clamp design is the same shape as the railing,	Gapes between parts is less than 2mm	Pass
Appropriate Usability of Clamp	Focusing on the clamp assembly	If the clamp is small and light enough so that it can be navigated by the client for regular usage	Under normal usage, the clamp will not hit or tangle the caretaker	Did not pass The caretaker needs the right side of the bed to move the client.

Detachability of the Main Body	Focusing on the entire assembly	Ask the caretaker to try to take off and put on the main body.	The caretaker takes under 15 seconds to take off main body	N/A because to test this, the main body still needs to be modified
Reasonable Strength for Locking Gear	Focusing on the clamp assembly	Use a torque wrench to tighten the locking gear until the gear starts to rotate or push up.	Under parallel gear, will not move under 35N/m torque	Pass
Glue Compatibility with PVC pipe	Focusing on arm assembly	If the glue for the PVC pipe works with the 3D-printed parts, test is passed.	After the glue sits for 30mins, will try to break the two-part by hand	Pass because it melts everything together; even a small surface is used to glue two pieces. They cannot be split by hand.
Rotational Mechanism of mount	Focusing on the mount assembly	Use a push scale to push onto the mounting surface on till the part start to move	Require more than 5kg to move not no more than 10Kg	N/A because it has not been tested yet

Next Steps Regarding Prototype Testing

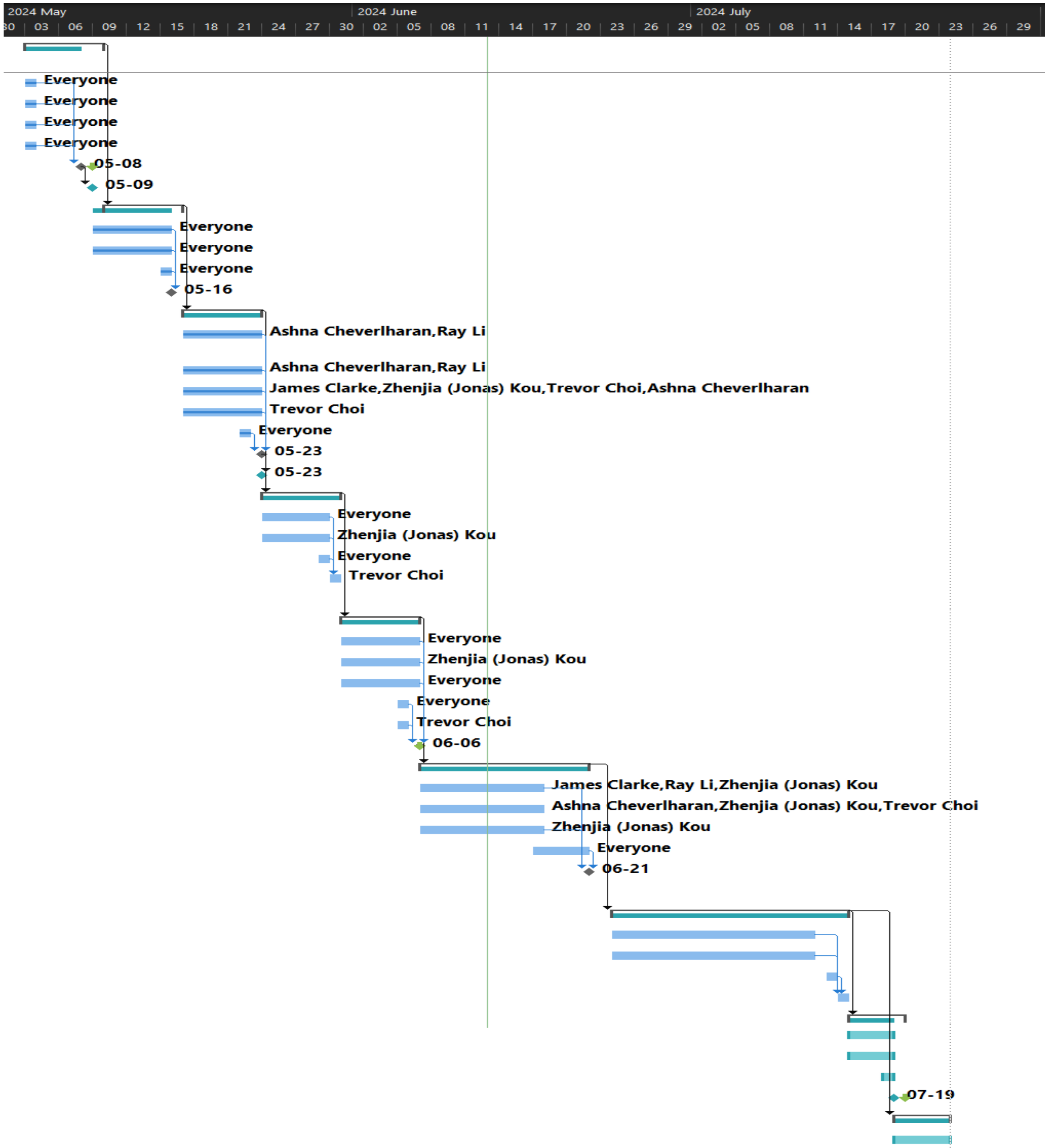
Currently, the phone mounting part is being printed and remains to be tested for its rotational mechanism, adjustability and strength. The updated clamp mechanism needs to be printed again to test for its features as well as its compatibility with the bar mechanism. Finally, the new gear locking part will be printed within the next couple of days to ensure that it is strong enough and will fit the pipe more securely.

Our goal is to ensure that all new parts are printed so that we can begin to assemble our subassemblies so that we have a physical prototype of prototype II before design day.

Upcoming Client Meeting III

In our upcoming client meeting, we plan on presenting our second physical prototype to the client. We will explain our design process as well as the pros and cons of the product. We will also explain what changes we decided to make to the first prototype to develop the second one. One thing that we noticed with our client is that visual representation seems to be a better method of explaining our design. Therefore, we will use some slides from our presentation in deliverable E to properly explain the transition from our first to second prototype. For our team, the goal of this client meeting is to receive feedback from the client, hence that will be our primary focus.

Our first prototype involved initial prototypes of each subassembly (clamp, arm and mount). Our second prototype is a physical prototype of the entire assembly, which is the phone bed mount. We will bring our prototype to the client meeting and test it on the client's bed railing to see if the railing can handle the weight of the clamp. Depending on the results, we can adjust the weight of the clamp along with the arm and phone mount respectively. Furthermore, we plan on persuading the client to attach the clamp to the bed frame for a more stable product. We will also explain how we plan on locating and adjusting the arm and phone mount while the client is in bed.



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Zhenjia (Jonas) Kou
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5 Other Considerations

5.1 Economics Report

Table 3: Cost Estimation

$	Cost	Material/Labor/Expense	Fixed/Variable/ Semi-variable	Direct/Indirect
$517,168	Production Material	Material	Variable	Direct
$1,078.5/year	Advertising	Expense	Fixed	Indirect
356,288/year	Labour	Labor	Variable	Direct
25,000 (1st year)	Production Equipment	Expense	Fixed & Variable	Direct
7800/year	Electricity and Heating	Expense	Fixed	Indirect
12,240/year	Rent	Expense	Fixed	Indirect
7,000/year	Overhead	Expense	Semi-variable	Indirect

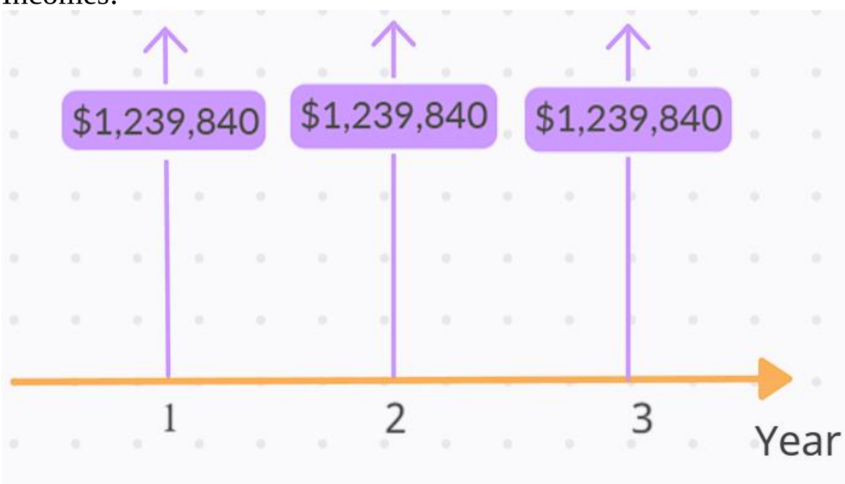
3-Year Income Statement

Cozy Capybaras Income Statement			
Year	2024	2025	2026
Sale Revenue	$1,239,840	$1,239,840	$1,239,840
Cost of Goods Sold			
Production Material	$517,168	$517,168	$517,168
Labour	$356,288	$356,288	$356,288
Total Cost of Goods Sold	$773,456	$773,456	$773,456
Gross Profit	**$466,384**	**$466,384**	**$466,384**
Operating Expenses			
Production Equipment	$25,000	-	-
Rent	$12,240	$12,240	$12,240

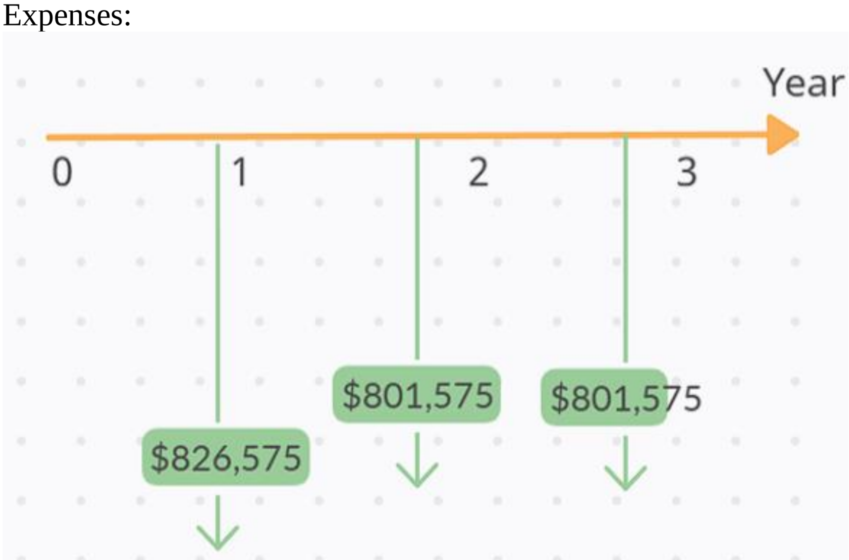
Overhead	$7,000	$7,000	$7,000
Electricity and Heating	$7,800	$7,800	$7,800
Advertising	$1,079	$1,079	$1,079
Total Operating Expenses	$53,119	$28,119	$28,119
Operating Income	**$413,265**	**$438,265**	**$438,265**

Break Even Point and Cash Flow Diagrams

Incomes:



Expenses:



NPV Values:
Discount Rate (i) = 8.25% (Government of Canada, 2023)

NPV (Operating Expense) = $\Sigma[FV/(1+i)^n]$
NPV (Operating Expense) = ($53,119)/$(1 + 0.0825)^0$ + ($28,119)/$(1 + 0.0825)^1$ + ($28,119)/$(1 + 0.0825)^2$
NPV (Operating Expense) = $53,119 + $25,975.98 + $23,996.29
NPV (Operating Expense) = **$103,091.27**

NPV (Production Equipment) = $25,000/$(1 + 0.0825)^0$ = **$25,000**

NPV (Rent) = $12,240/$(1 + 0.0825)^0$ + $12,240/$(1 + 0.0825)^1$ + $12,240/$(1 + 0.0825)^2$
NPV (Rent) = $12,240 + $11,307.16 + $10,445.41
NPV (Rent) = **$33,992.57**

NPV (Overhead) = $7,000/$(1 + 0.0825)^0$ + $7,000/$(1 + 0.0825)^1$ + $7,000/$(1 + 0.0825)^2$
NPV (Overhead) = $7,000 + $6466.51 + $5973.68
NPV (Overhead) ≅ **$19,440.19**

NPV (Electricity and Heating) = $7,800/$(1 + 0.0825)^0$ + $7,800/$(1 + 0.0825)^1$ + $7,800/$(1 + 0.0825)^2$
NPV (Electricity and Heating) = $7,800 + $7205.54 + $6656.39
NPV (Electricity and Heating) = **$21,661.93**

NPV (Advertising) = $1,079/$(1 + 0.0825)^0$ + $1,079/$(1 + 0.0825)^1$ + $1,079/$(1 + 0.0825)^2$
NPV (Advertising) = $1,079 + $996.77 + $920.80
NPV (Advertising) = **$2,996.57**

Selling Price Per Unit = $80/unit
Material Cost Per Unit = $49.38/unit
Labour Cost Per Unit = $200,000/(15,498 units) ≅ $12.90/unit

NPV Average Selling Price = [$80/$(1 + 0.0825)^0$ + $80/$(1 + 0.0825)^1$ + $80/$(1 + 0.0825)^2$]/3
NPV Average Selling Price = ($80 + $73.90 + $68.27) / 3
NPV Average Selling Price ≅ **$74.06/unit**

NPV Average Material Cost Per Unit = [$49.38/$(1 + 0.0825)^0$ + $49.38/$(1 + 0.0825)^1$ + $49.38/$(1 + 0.0825)^2$]/3
NPV Average Material Cost Per Unit = ($49.38 + $45.62 + $42.14) / 3
NPV Average Material Cost Per Unit ≅ **$45.71/unit**

NPV Average Labour Cost Per Unit = [$12.90/$(1 + 0.0825)^0$ + $12.90/$(1 + 0.0825)^1$ + $12.90/$(1 + 0.0825)^2$]/3
NPV Average Labour Cost Per Unit = ($12.90 + $11.92 + $11.01) / 3
NPV Average Labour Cost Per Unit ≅ **$11.94/unit**

Break-Even Point:
Break-Even Point = Operating Expenses/(Price/Unit - Material Cost/Unit - Labour Cost/Unit)
Break-Even Point = $103,091.27/($74.06/unit - $45.71/unit - $11.94/unit)
Break-Even Point = 6,282 units

Therefore, based on three years of expenses, the break-even point is 6,282 units.

Assumptions

1) **Demand and Revenue:**
According to our research, 2.7 million Canadians over the age of 15 have a mobility disability. About 57.4% of Canadians with mobility disabilities require some sort of workplace accommodations to complete their required tasks (Statistics Canada, 2020). Out of this percentage of people, our goal is to reach around 1% of the population. This is an ambitious goal, but we are confident that it is attainable and realistic since our product has unique features of adjustability and compatibility and will attract a wide range of customers.

(2,700,000) *(0.574) *(0.01) = 15,498 products sold per year

Our selling price per unit is $80. This seems like a large amount for the average consumer. However, we are considering the fact that the Government of Canada covers a percentage of mobility aids for those in need. In Ontario, the government covers the cost of equipment for people of physical disabilities (Government of Canada, 2022).

Therefore, our estimated annual sales revenue is ($80/unit) *(15,498 units) = $1,239,840

2) **Material Cost:**
For our device, the price was $45.71 per unit. If we were to purchase material in bulk rather than as individual components, we could save around 27% on the cost of materials (Davis, 2023). This will reduce our per-unit material cost to approximately $33.37.

($45.71 per unit) * (1 – 0.27) = $33.37 per unit
($33.37 per unit) * (15,498 units) = $517,168.26

3) **Labour Cost:**
Based on our calculations, we will be producing 15,498 units per year. Assuming that each employee hired can produce around 7 units each day and there are 260 working days in a year, we will be able to hire 9 full-time employees.

[(15,498 units per year)/(260 working days)] = 59.61 ≅ 60

Every day, 60 units should be produced to hit our quota of 15,498 units per year

(60 units produced) / (7 units produced by each employee per day) ≅ 9 full time employees

Assuming that each employee is paid the Ontario minimum wage of $16.55/hour not including the standard 15% employee benefit (MaRS Startup Toolkit, 2021).

(8 hours per day) * (260 working days per year) * ($16.55/hour) * (1.15) * (9 employees) ≅ $356,288.4

4) **Electricity and Heating Expenses**:
Based on our research, on average, it costs a small business $650/month for expenses related to electricity and heating (Constellation, 2022). We need to calculate the annual cost

($650 per month) * (12 months) = $7800

5) Rent:
Based on our research, the average rental rate for a warehouse space is around $0.85 per square foot per month (Prologis, 2023). We need to calculate the rent cost for an entire workspace. To rent a 1200-square-foot workspace will cost us approximately $12,240 per year

($0.85 per square foot per month) * (1200 square feet) * (12 months) = $12,240

6) Overhead:
These are costs that include insurance and administration work. These costs will be around $7,000 annually.

7) Advertising:
In terms of how we will be marketing our product, we will mainly be using social media platforms such as Instagram and Facebook. The average cost per 1000 impressions on Facebook is $7.19 (Nutshell, 2023).

($7.19 per 1000 impressions) * (150,000 customers / 1000 impressions) = $1,078.5

To reach our goal of 150,000 customers per year, we will spend $1,078.5 on advertising each year.

8) Production Equipment:
In total, the equipment required to produce our device is around $25,000 in the first year.

References:

Nutshell. (2023, November 21). *What's the cost of social media advertising?* https://www.nutshell.com/blog/cost-of-social-advertising#:~:text=Average%20social%20media%20advertising%20pricing,(paid%20to%20ad%20networks)

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Davis, M. (2023, September 18). *Buying in bulk could save shoppers 27%, on average*. LendingTree. https://www.lendingtree.com/credit-cards/study/bulk-buying/

Government of Ontario. (2022, December 12). *Assistive Devices Program*. https://www.ontario.ca/page/assistive-devices-program

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MaRS Startup Toolkit. (2021, January 3). *Employee benefits and benefits packages: What ontario employers should know*. https://learn.marsdd.com/article/employee-benefits-and-benefits-packages-what-ontario-employers-should-know/

Prologis. (2023, June 23). *How much does it cost to rent a warehouse?* https://www.prologis.com/what-we-do/resources/how-much-does-it-cost-to-rent-warehouse

5.2 Intellectual Property Report

Intellectual Properties

1. Hospital-Bed Phone Mounting Plate

Website: [Hospital-bed phone mounting plate - ROSTEN; WILLIAM J. (freepatentsonline.com)]

Description: This patent is classified as a United States Patent of code 4602755. It is a patent for a hospital-bed phone mounting plate that permits swinging movement of a wall-type phone mounted in a vertical plane, so that as the head of the bed is raised or lowered, the wall phone will remain continuously in a vertical plane even though the phone-mounting plate is pivoted along with the head portion of the bed. An adjustable clamp mounts the plate to a top rail of the hospital bed. Spacers at the four corners of the mounting plate are used to wrap phone excess phone wire.

The similarities to our product include that the product permits a swinging feature. Furthermore, it is similar in the sense that our design can also adjust the angle of the plate that the phone is attached to.

2. Patient Bed Having Head-of-Bed Angle Indicator And Mobile Phone Holder

Website: https://patents.google.com/patent/US20230320913A1/en?q=(phone+mount+bed)&oq=phone+mount+for+bed

Description: This patent is classified as a United States Patent of code US20230320913A1. It is classified as a control or drive mechanism. It is a patient control unit for controlling functions of a hospital bed including a plurality of user inputs to control the functions of the hospital bed. It also includes a dock to secure a handheld phone in place. Its primary feature is a head-of-bed angle (HOBA) lockout selector that is used to signal a controller to prevent a head section of the bed from being moved below a threshold.

The similarities to our product include that the product has a dock to secure a phone like how our device includes a phone with Velcro to hold the phone in place. Similar to our product, it also includes a mechanism to control the angle. However, in our case, it is to control the angle of the mount whereas for this mechanism, it is to control the head section of the bed.

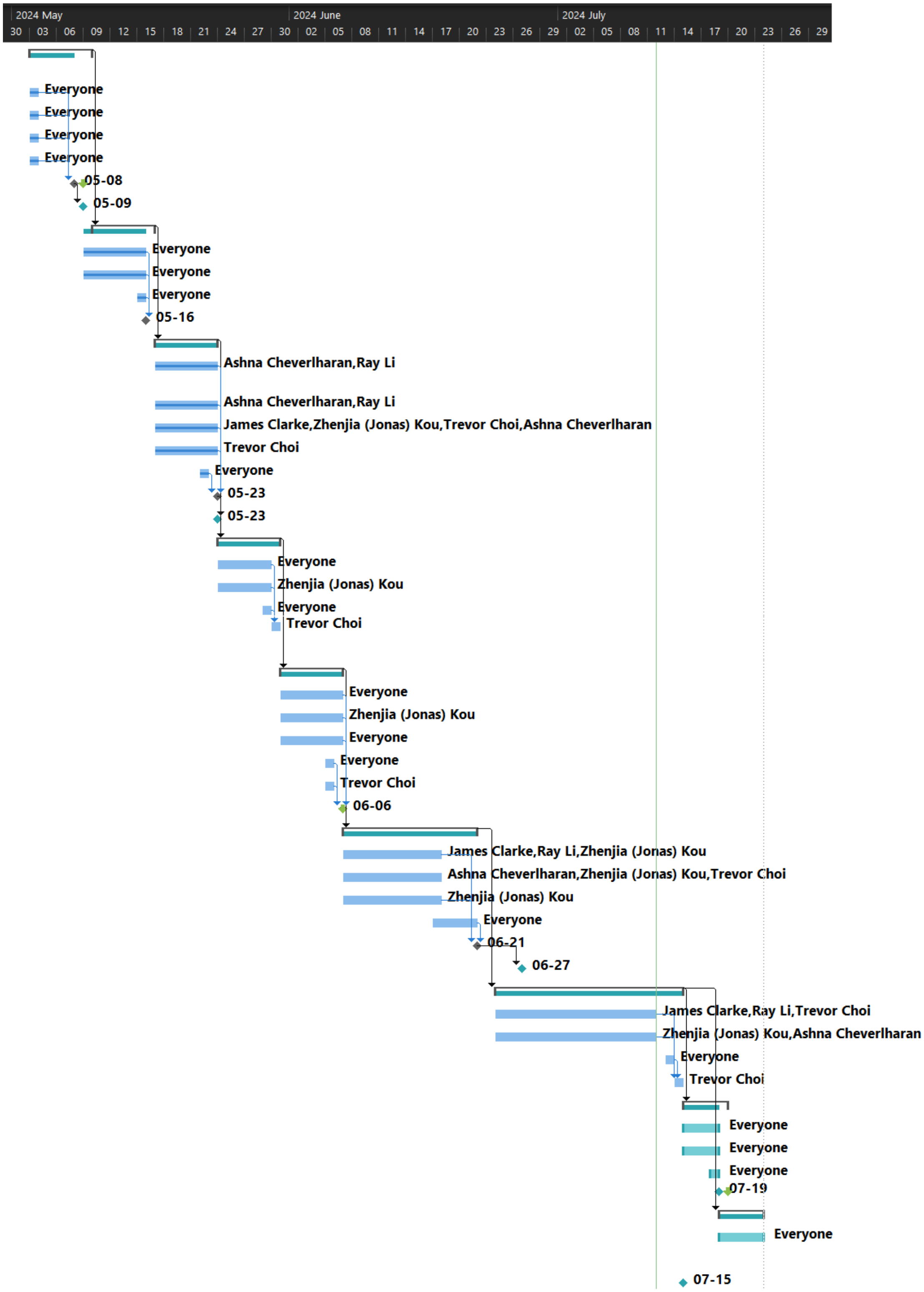
Importance of Intellectual Properties

The type of intellectual property that we chose to focus on in particular are patents. Intellectual properties are any form of knowledge or expression created using a person's intellect and can be legally protected. They are important because they help protect your ideas from other people copying them.

A patent, in particular, is a temporary limited legal right granted to an inventor by a government to prevent others from manufacturing, selling or using his/her invention. Inventors provide full description of the invention in a patent application, which is published by the patent office 18 months from the first filling date. Patents are important because they essentially documents protecting the rights of the inventor and a public repository of technical information. Their importance lies in the fact that they promote the sharing of innovative technological information.

In our case, we are focusing on inventions and product designs, in the form of patents. The legal constraints placed on our product is that we cannot legally manufacture or use other peoples' inventions as our own. However, we need to consider that it is acceptable to use the patented ideas above and they would not cause patent infringement as there are not enough similarities.

Project Plan Update



6 Design Day Pitch and Final Prototype Evaluation

Summary of Project for Judges

We designed a phone bed mount that our client with limited mobility can use to navigate her phone in bed. Her caregivers can set up the phone bed mount when needed, and it can be swung out of the way when not in use.

Design Day Presentation

For design day, we plan on having our physical prototype available for demonstration. We will also bring previous prototypes in case questions are asked about them. We are keeping all our presentation material strictly digital as it will be more efficient in demonstrating our final prototype. We have two presentations and will have them displayed on two separate computers.

The first presentation will only include images of our prototypes and concepts. This presentation will be set to go in a loop and will act strictly as a visual display. The second presentation is technical and will be used when giving the 3-minute pitch. The links for each presentation are below.

Pitch Presentation:

https://docs.google.com/presentation/d/1Qv5MafbBw2XmpgRtk57l3fNCtzJM2LU8ihmjj8KZwVw/edit?usp=sharing

Prototype Presentation:

https://docs.google.com/presentation/d/117_oA6DEg4PbMvA86Bf6O8qqiAQZpq7EeZGnBrQzVFw/edit?usp=sharing

3 Minute Pitch

The 3-minute pitch will go along with the pitch presentation and will be presented by Ashna. It will also include a prototype demonstration at the end, presented by Jonas. We will then leave 5 minutes to answer questions.

7 Video and User Manual

Add link to video.

8 Conclusions

9 Bibliography