­­­­GNG2101

Design Project Progress Update

SMIJ TECH B 1.3

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List of Acronyms and Glossary

Table 1. Acronyms

|  |  |
| --- | --- |
| **Acronym** | **Definition** |
| BOM | Bill of Materials |
| PVC | Polyvinyl Chloride |
|  |  |
|  |  |
|  |  |

# Introduction

This project deliverable document outlines each deliverable that was completed by the team throughout the semester. The deliverables outline the team’s process in designing, developing, and finally creating the bed phone mount for the client. The purpose of this document is to demonstrate the process of creation, as well as feedback that the client provided throughout the semester. All information regarding the client’s identity is to remain confidential.

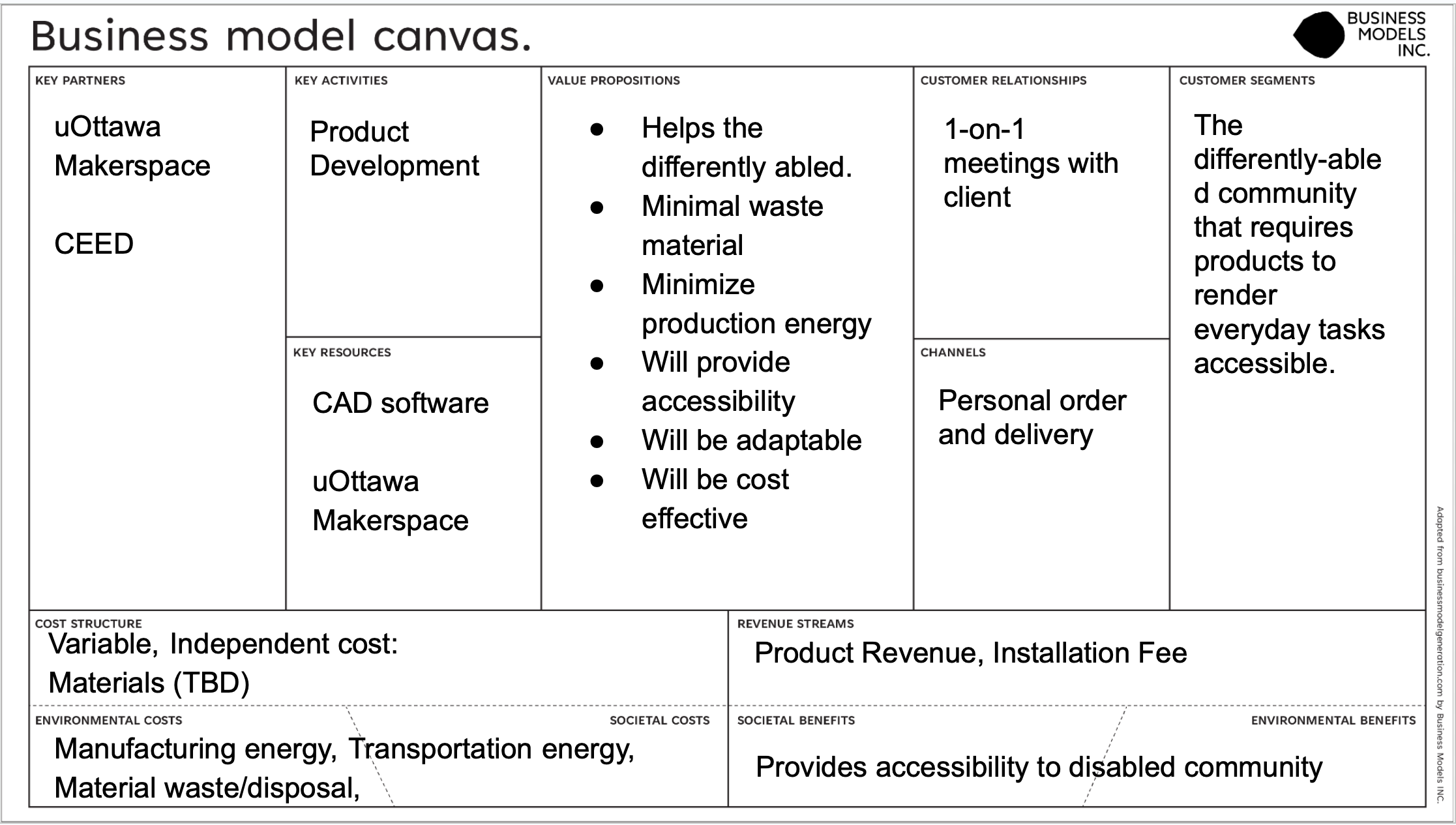
# Business Model Canvas and DFX

## Business model and sustainability report

1. Identify and describe your value proposition that would be well suited to commercializing your team’s product. Discuss the reasons for your choice.

Our team has been tasked with making a bed mount for a cell phone, which would allow our client to lie on their side while using their phone in bed.  With producing a valuable project in mind, our team has come up with a couple key features for our product that demonstrate its value. While designing for usability, the project will healthily affect the user’s life. The product will be adaptable to many conditions, meaning it will be able to move from client to client and adapt to each of their needs. The value of improving one's life is irreplaceable, and by making a product both to benefit our client’s life and others, we are designing a product that would be commercialized well.

1. Fill in a triple bottom line business model canvas by answering the how, what, who and how much of your chosen business model.



S

1. Describe the core assumptions that you have made in developing your business model canvas and comment on its feasibility. Important: These core assumptions should be based on the business model you have chosen and not on your prototype (e.g. what type of clients do you assume your product will attract?).

In developing our business model canvas, we have outlined a few core assumptions. The first being that our clientele will be the differently abled community, and that we will be using a business model that does custom orders/deliver to really tailor to the needs of each. Another assumption is that the bulk of our final product will be made of 3D printed components, and that there would be infrastructure in place to maintain a high order volume using 3D printed parts at a reasonable cost. With this in mind, we will not be using the 3D printer until the final prototype, to minimize waste. This also brings on the assumption that we will have access to free materials (at home, most likely) to make our initial prototype models. Finally, we will create all our parts in-house, and not use an outside source, such as a manufacturer.

1. Provide a sustainability report that reflects on at least two of your product’s major social, environmental, and economic impacts, both positive and negative. Perform a simple analysis of these impacts and use this analysis to help you fill in the triple bottom line of your business model canvas.

Our team would like to maintain high standards regarding our product’s major social, environmental, and economic impacts. The phone bed mount that we are developing will attempt to promote the betterment of our planet and improve the lives of the people who live here.

The two major areas of impact that we will be addressing include the phone bed mount’s benefits to an individual’s quality of life and its minimal environmental impact. By focusing heavily on these two important topics, we hope to be able to provide sustainable, positive outcomes with our products.

This product will help people with mobility issues attain that same level of comfort while on their phone in bed. As of now, our client is not able to hold up their phone while lying in bed. With features such as an adaptable arm and an adjustable angle of the phone, anyone will have the tools to perform this action. The phone bed mount will prioritize independence and induce positive social benefits.

Additionally, our team must be conscious of the environmental effects caused by similar products and how we may diminish the negative environmental impact of our own product. One of our goals is to engineer a product which could last a lifetime. A phone mount that is strong, versatile, and effective will never need to be replaced. A smart design would minimize the number of materials and energy consumed, while still maintaining maximum functionality for decades.

While developing our product, we will make an active effort to select sustainable materials that are sturdy and non-toxic to the environment. With that said, to implement reusability features for our phone bed mount, the phone will be attached to the mount using Velcro. Even though Velcro is made of plastic, the client already has a Velcro phone case to attach their phone to their wheelchair. Reusing this multipurpose fastener will be better for the planet because otherwise, we would have to create an entirely new system to attach their phone, which would result in the need to use more materials rather than just Velcro. Furthermore, we will employ strong building techniques to ensure that the joints and individual pieces of the phone mount will not break over time.

Sustainability is a crucial aspect of our product that we will be focusing our attention on during development. Our goal is to supply positive social and environmental impacts with the creation of our phone bed mount.

## Design for X

After the first meeting with the client, we have gathered essential information that will aid us in the commencement of the design of our product.  Once we revised the information we obtained from the meeting, we have established that the most important design factor is designing for usability. Because our client is of different ability, designing a product that catered to their ability is crucial for the product’s success. A few specific requests were made by the client, such as the mount’s ability to be easily removed and installed. This request includes the phone’s ability to be attached using pre-existing Velcro on their phone case.

Another important element of our design process is designing for reliability, as this product will be used by the client every day. With everyday use, a product is subject to wear and tear, therefore it needs to be both resistant and durable. The core function of our product is its ability to move from one side of the bed to the other, and stay in place while being used, which emphasizes our need to create a strong and durable product.

Next, ease of installation of the bed mount is crucial. Our product should be ready to function as intended as soon as it is delivered to the client to emphasize ease of use of our product. The set-up of the device will be provided by the full-time caregiver, meaning we have both our client and their caregiver as our product users. The product must be easy to install to ensure that time is not waste on installation, but rather caring for the client.

In addition, designing for compatibility is important for this product.  The client has specifically requested that the product must work with their style of bed to be functional. To fulfill this request, our team took all necessary measurements of the client's bed to ensure that our product will work seamlessly with the client’s environment. For future production of the product, it is important for us to create a mount that is compatible with not only the client’s specific situation, but with any bed or bed frames. This will make the product more accessible to a wider market.

Lastly, designing for user experience will be important in the design process of this project. Having an accessible, easy, and friendly user experience. In addition, a surprise we have considered for the client is to add slight decorations resembling that of the Ottawa Senators hockey team. This idea was inspired by seeing their bedroom, and the extensive decorations of the hockey team on display throughout the room.

# Problem Definition, Concept Development, and Project Plan

## Problem definition

The following table outlines the client needs we learned during Client Meeting 1, as well as includes criteria that were outlined on the Maker Repo page with information about our client. The Needs and Design Criteria and ranked on a scale of 1-3, with 1 being “least important”, 2 is “medium importance” and 3 is “most important”, with corresponding colors to make the rankings easier to comprehend.

Table 3. Client Needs

|  |  |  |
| --- | --- | --- |
| **Priority** | **Need** | **Design Criteria** |
| 3 | Current wheelchair set-up uses Velcro to prop the client’s phone. | Phone attaches to bed mount using Velcro. |
| 3 | The stand can be removed easily. | The mount has the same circumference as the current one being used with the wheelchair. |
| 1 | Should look presentable. | The colors look good with the room and the mount is neat. |
| 2 | Mount can rotate a little bit to show different angles. | Mount has a rotating component. |
| 3 | Mount allows the client to lay on their left side. | The mount reaches from one side of the bed to another, by attaching to the railing on the right side of the bed. |
| 2 | Mount can be moved to the side/pushed away if it’s too close | The mount is low and lightweight. |
| 1 | Be able to charge the phone while using it. | Cables can be wrapped around the mount and the mount has close access to a wall outlet. |

**Problem Statement**

Our client needs a phone bed mount, with a Velcro attachment, that would allow them to lie on their left side while using their phone in bed. The mount must be easy to remove by theircaregiver, while being straightforward to set up and adjust.

**Metrics**

The following table lists the measurements we made of the bed at the end of Client Meeting 1. These measurement metrics are to be followed and thoroughly considered during the design process as the product must be compatible with these measurements.

Table 4. Bed Measurements

|  |  |
| --- | --- |
| **Section** | **Measurement (cm)** |
| Railing Width | 3.6 |
| Railing bar height | 2.8 |
| Bed total Width | 100 |
| Bed Length | 213.2 |
| Railing Height | 30 |
| Headboard Width | 2.2 |
| Half Rail | 14 |
| Railing Circumference | 5 |
| Bottom Rail Height | 2.2 |
| Bed Height | 89.5 |

Table 5. Benchmarking

|  |  |  |  |
| --- | --- | --- | --- |
| **Product** | **Link** | **Advantages & Properties** | **Disadvantages** |
| Lamicall Bed Phone Mount (Amazon best seller in the category) | [https://www.amazon.ca/Phone-Holder-Bed-Gooseneck-Mount/](https://www.amazon.ca/Phone-Holder-Bed-Gooseneck-Mount/dp/B07S9JXQP2/ref=sr_1_1_sspa?hvadid=604601336794&hvdev=c&hvlocphy=9000668&hvnetw=g&hvqmt=e&hvrand=17650510984168854699&hvtargid=kwd-391683109650&hydadcr=27680_14575664&keywords=bed%2Bmount%2Bphone&qid=1696024442&sr=8-1-spons&sp_csd=d2lkZ2V0TmFtZT1zcF9hdGY&th=1) | * Completely flexible as the arm has no fixed joints and is completely poseable (360-degree rotation) * Suitable for large phones * Free-hand phone stand * Arm is 85 cm long | * Does not appear sturdy because of the “gooseneck” design lacking structure * Only clamps to flat surfaces (clamp has a range of 0 to 6cm) |
| Samhousing tablet stand | [https://www.amazon.ca/Samhouse-Rotating-Aluminum-iPhoneXS-Nintendo/](https://www.amazon.ca/Samhouse-Rotating-Aluminum-iPhoneXS-Nintendo/dp/B07P8YHKLF/ref=sr_1_26?hvadid=604601336794&hvdev=c&hvlocphy=9000668&hvnetw=g&hvqmt=e&hvrand=17650510984168854699&hvtargid=kwd-391683109650&hydadcr=27680_14575664&keywords=bed+mount+phone&qid=1696111937&sr=8-26) | * Very durable * Most stable to hold a phone * 360-degree rotation * Has 4 joints * Can be attached to any surface up to 52mm thick * Compatible with smartphones and tablets | * Heavy (made of aluminum) * Since the client lays on theirleft side, it will not be visible * Only clamps to flat surfaces |
| Pemsem Phone Floor Holder | [https://www.amazon.ca/Adjustable-Flexible-Standing-Universal-Readers/](https://www.amazon.ca/Adjustable-Flexible-Standing-Universal-Readers/dp/B089K74W6V/ref=sr_1_25?hvadid=604601336794&hvdev=c&hvlocphy=9000668&hvnetw=g&hvqmt=e&hvrand=17650510984168854699&hvtargid=kwd-391683109650&hydadcr=27680_14575664&keywords=bed+mount+phone&qid=1696111937&sr=8-25) | * Easy to position as it is not mounted to the bed * Durable design * Fits devices ranging from 4.7 to 12.9 inches * Five degrees of freedom * 360-degree rotatable * Height can be adjusted with range of 27.5 to 55 inches | * Heavy (made of carbon steel) * Not easily portable * Can’t be removed from bed |

**Target Specifications**

Table 6. Benchmark Product #1

|  |  |
| --- | --- |
| **Features to Keep** | **Features to Avoid** |
| Flexible to position | Not sturdy |
| Long arm | May fall and injure client |
| Suitable for large phones | Only mounts to flat surface |

Table 7. Benchmark Product #2

|  |  |
| --- | --- |
| **Features to Keep** | **Features to Avoid** |
| Durable | Mount on the headboard |
| Stable | Weight is too heavy – material is too heavy-duty |

Table 8. Benchmark Product #3

|  |  |
| --- | --- |
| **Features to keep** | **Features to Avoid** |
| Easy to position | Challenging to move around (not very portable) |
| Durability | A floor mount. |
| Suitable for large phones | Heavy, made of carbon steel. |

In summary, our product has a few key target specifications that will cater to its success. From the benchmarking above, we believe a successful phone mount will include some of the listed attributes. Our highlighted target specifications outline a mount that is light and durable, mounted to the bed, has a large degree of motion, and is easy to use and position.

**Global Design Concept**

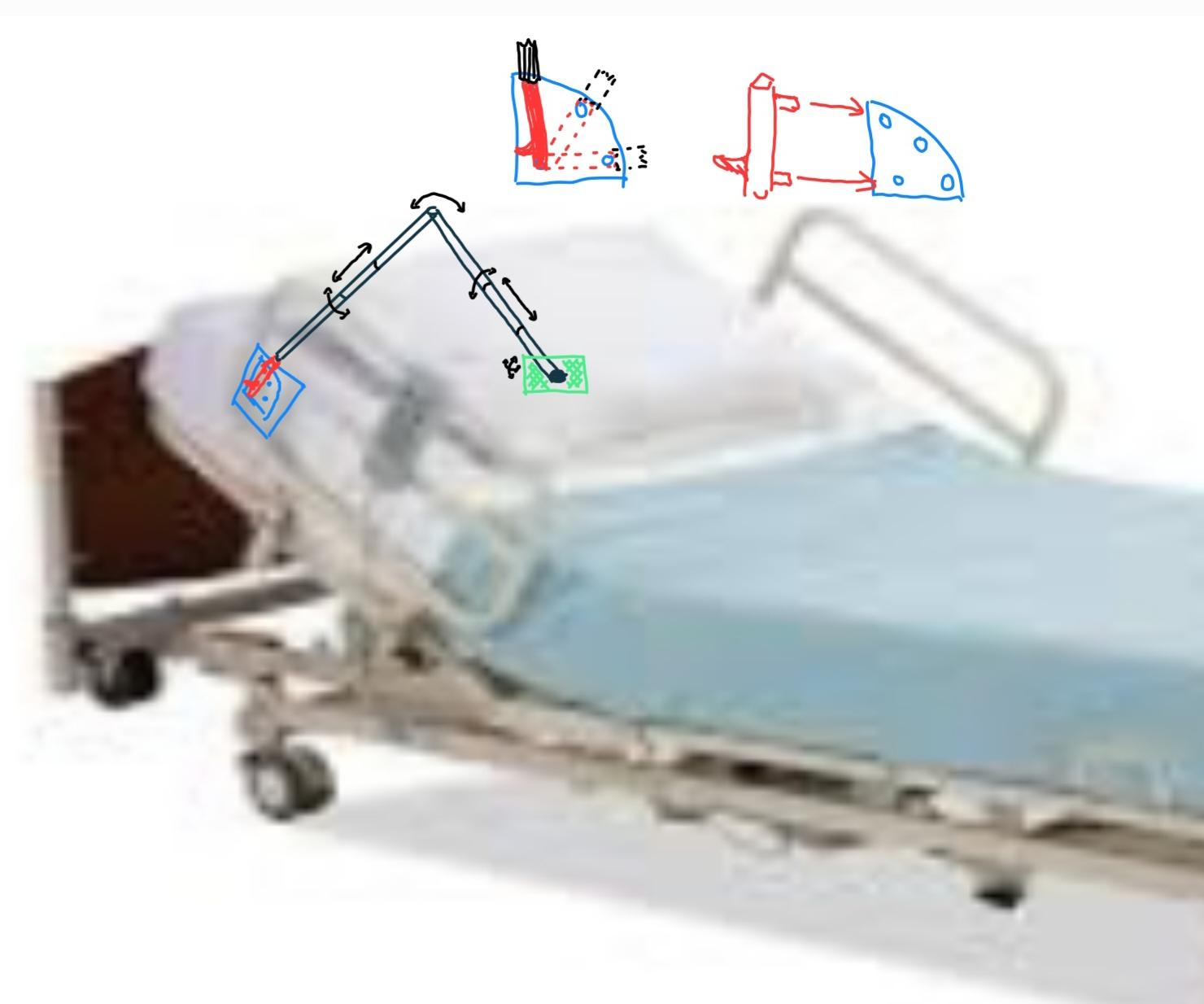
There are four major components to our global design concept; the base, the handle, the main length, and the phone stand. Firstly, the base will be fastened to the bar on the right side of the bed. It has a quarter-circle shape with four holes in it. One hole is near where the center of the circle would be and the other three are around the curved perimeter.

The handle can be inserted into and/or removed from these holes in the base. It has two smaller rods that insert into the center hole and one of the outer holes, allowing the client to adjust it with different angles. The handle is permanently attached to the main part of the phone stand.

The main length of the phone mount has three pieces. Firstly, a vertical rod is attached to the handle. Next, a right-angle joint is connected to the top of the vertical rod, allowing the phone stand to rotate out of the way. Then, a horizontal rod is on the other side of the joint and can rotate up and down to adjust the angle of the phone.

Finally, the phone stand is attached to that horizontal rod. It is a rectangular panel with Velcro on it. The rough side of the Velcro will be on the mount, while the soft side will be on the client’s phone, so that they can attach their phone easily.

Figure 1. Global Design Concept



One of the benefits to this design is that it allows for multiple degrees of motion, a feature we highlighted in our target specifications. The phone’s angle can move up and down, the horizontal part swings out of the way of the bed, and the handle and base allow for three different positions, all of which would provide the same level of security for the device. Another advantage of this design is that the phone mount is easily removable from the base, making it easy to position. In addition, the Velcro system allows for the phone stand to be used with any size phone. All that is required is the Velcro attachment to the device.

A drawback to this concept could be that the base is not as easily removable as the main part of the phone mount. One of our target specifications mentions that our design should not be challenging to move around. The client could either have someone else uninstall the base so that it could be used on another bed, or they could have two separate bases that stay on their respective beds and just move the main part between beds.

**Other Design Concepts:**

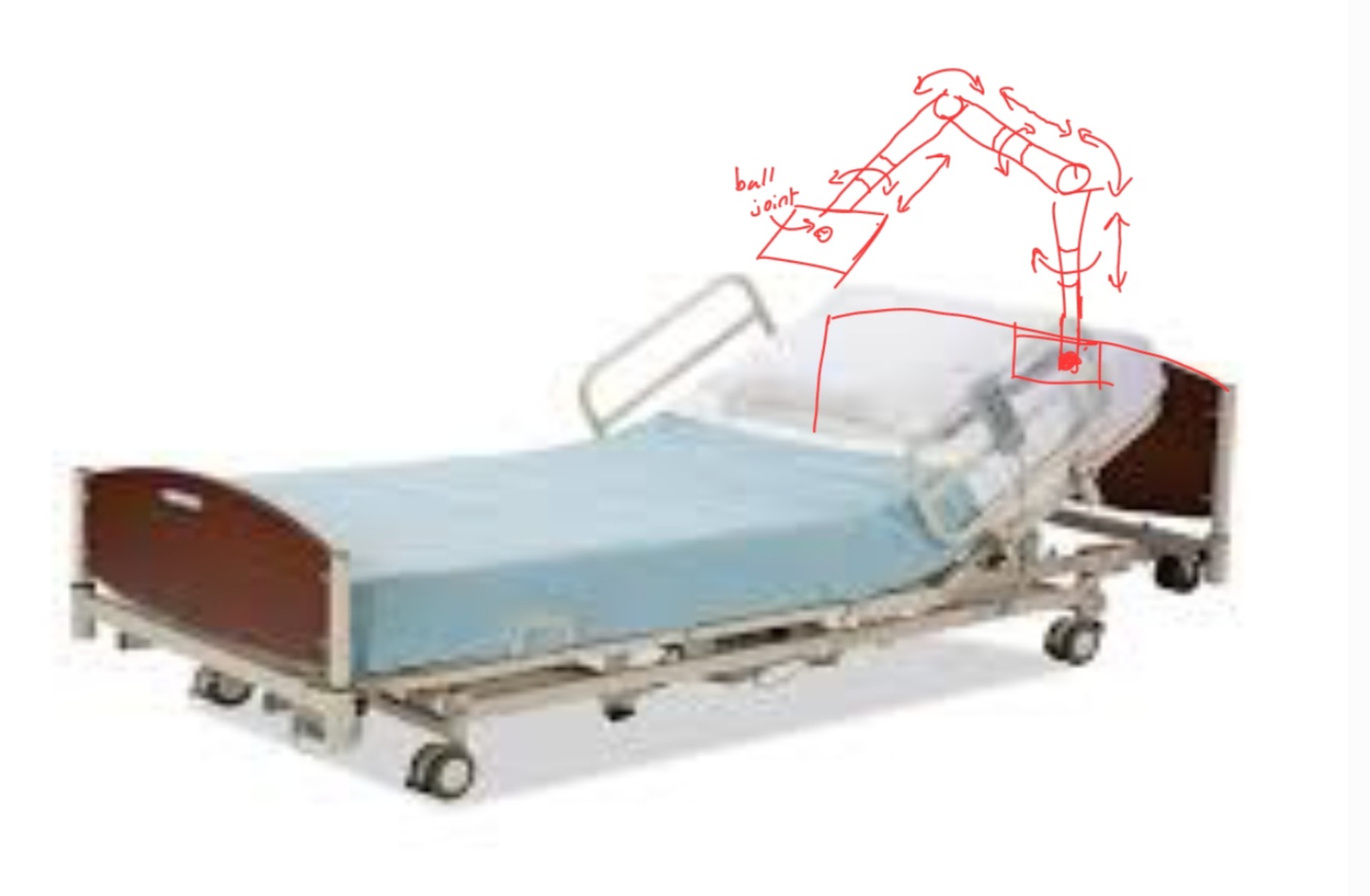
Figure 2. Design Concept #1



Figure 3. Design Concept #2



Figure 4. Design Concept #3



## Project plan

TA granted that we skip Wrike for this deliverable as we still do not have access.

# Detailed Design and BOM

## Detailed design

**Client Feedback**

For our second client meeting, we presented three of our best designs to our client in order to gain feedback and know how to move forward with our upcoming prototypes. The following images are the designs we presented to our client, and the order coincides with what we have outlined in the table below.

Figure 5. Design Shown to Client #1

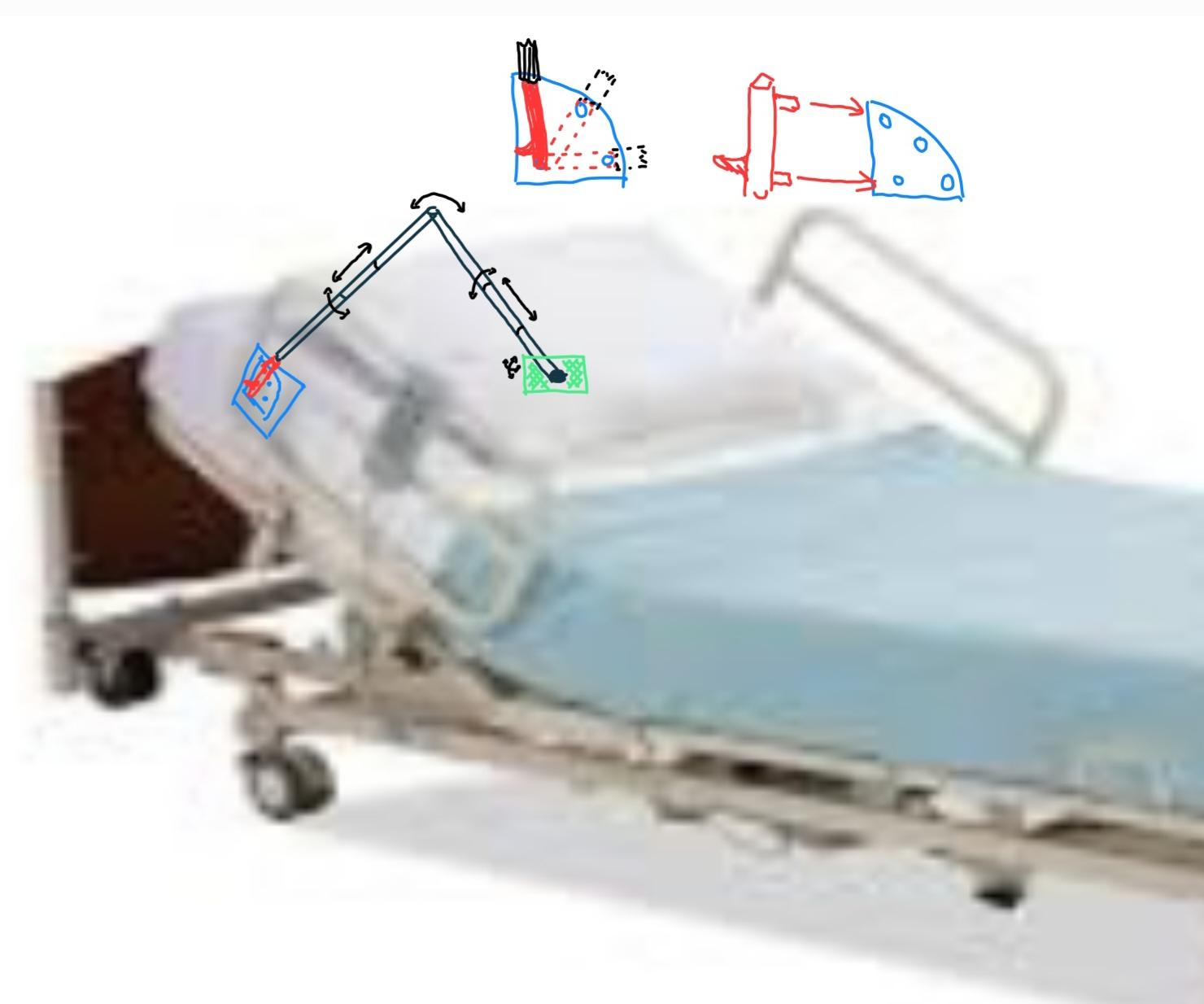


Figure 6. Design Shown to Client #2

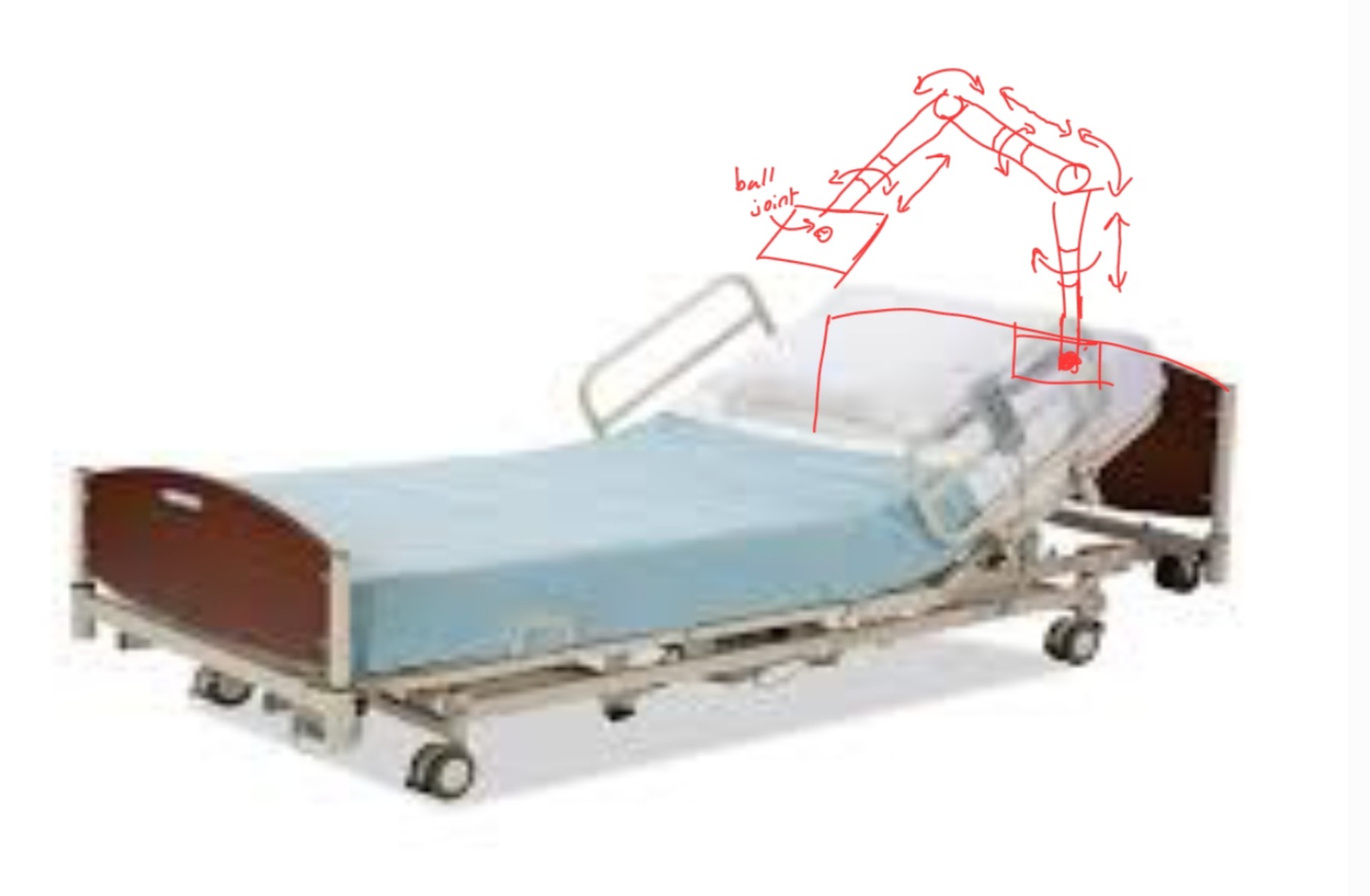


Figure 7. Design Shown to Client #3



The following table organizes the feedback we got from our client at Client Meeting 2.

Table 9. Client Meet Feedback

|  |  |
| --- | --- |
| **Design** | **Feedback** |
| **1** | * Likes the adjustability * Likes that we plan to use Velcro * Likes that it’s easy to remove * Doesn’t mind that there will be a small permanent attachment to her bed |
| **2** | * Subtle negative reaction (facial expression) regarding the mount being attached at the back of the bed * Likes its level of mobility |
| **3** | * Likes the mobility * Likes that its attached to the left side |

After asking the client what they liked best, they stated that the first design was their favorite, as it seemed the most stable and to have the best range of motion, while remaining sturdy. We told them ur plan to avoid making a phone mount that can rotate the phone 360 degrees forward/backward, as that would make it less stable and would increase the risk of it flipping around, and they were in agreement with this plan. To reinforce what we have in mind, we brought up an option to mount it on the left side, and they confirmed that we cannot do that because their arm will hit the phone mount and knock it out of the way.

**Skills and Resources**

Our team brings a diverse skill set and valuable resources to the table to successfully complete our project. Drawing from our past project work, we have gained hands-on experience in project management and problem-solving, as most of us have experience from the first-year course, GNG 1103. This equips us to work throughout our project more efficiently, as we have an idea of how to complete these deliverables effectively. With three of four team members being in Mechanical Engineering, we have gained experience using SolidWorks in our other courses, and this enables us to design and prototype with precision. All members have experience in coding, and we have a member studying Software Engineering, which leaves room for future design improvements. Another key resource is our access to the uOttawa Maker Space. This provides us with tools and a collaborative workspace, facilitating efficient prototyping and testing, as well as free access to certain materials and machines. With these combined skills and resources, we are well-prepared to tackle the project's demands and successfully achieve our goals.

**Time Assessment**

Our team predicts that we will be able to implement our design by the end of the semester, following the timeline of this course and its corresponding deliverables. Thankfully, we have been able to complete our deliverables very efficiently, having almost all of them completed the day prior to their due date. This grants us time to peer review and edit and add final touches to our work.

We are all students with heavy courseloads, all of us being in demanding programs such as Mechanical and Software engineering, so we anticipate the busy midterm season will make it challenging for us to complete work, and deliverables may be put on the back burner. Fortunately, we coordinate our time well and consistently hold weekly team meetings. This is where work gets assigned to each member, and the bulk of the content is completed. If a team member is unable to attend, due to being occupied with extracurriculars or the need to prioritize studying for an upcoming exam, we compensate by assigning them roles we know they would excel in and wouldn’t need to spend too much time completing.

Through efficient planning, communication, and a common desire to succeed in this course, we all anticipate being able to complete and provide a successful final prototype to our client.

**Critical Assumptions**

One critical product assumption that could significantly impact our ability to implement the design is the availability of a specific, essential component/material. If we rely on a unique or custom-made part that becomes inaccessible or outside the budget, it could cause delays or force us to revise our design, potentially affecting the product's performance and functionality. Therefore, it's necessary to have multiple options for different materials available for our final product. Another assumption made is the flexibility in usability of the product. Since we’re making this product for one specific client, it is still important to consider the other needs of all possible clients and not make it too specific, as that would limit the future market.

**Detailed Design**

The following images show a depiction of our prototype’s construction and its subsystems.

Figure 8. Prototype’s Design #1

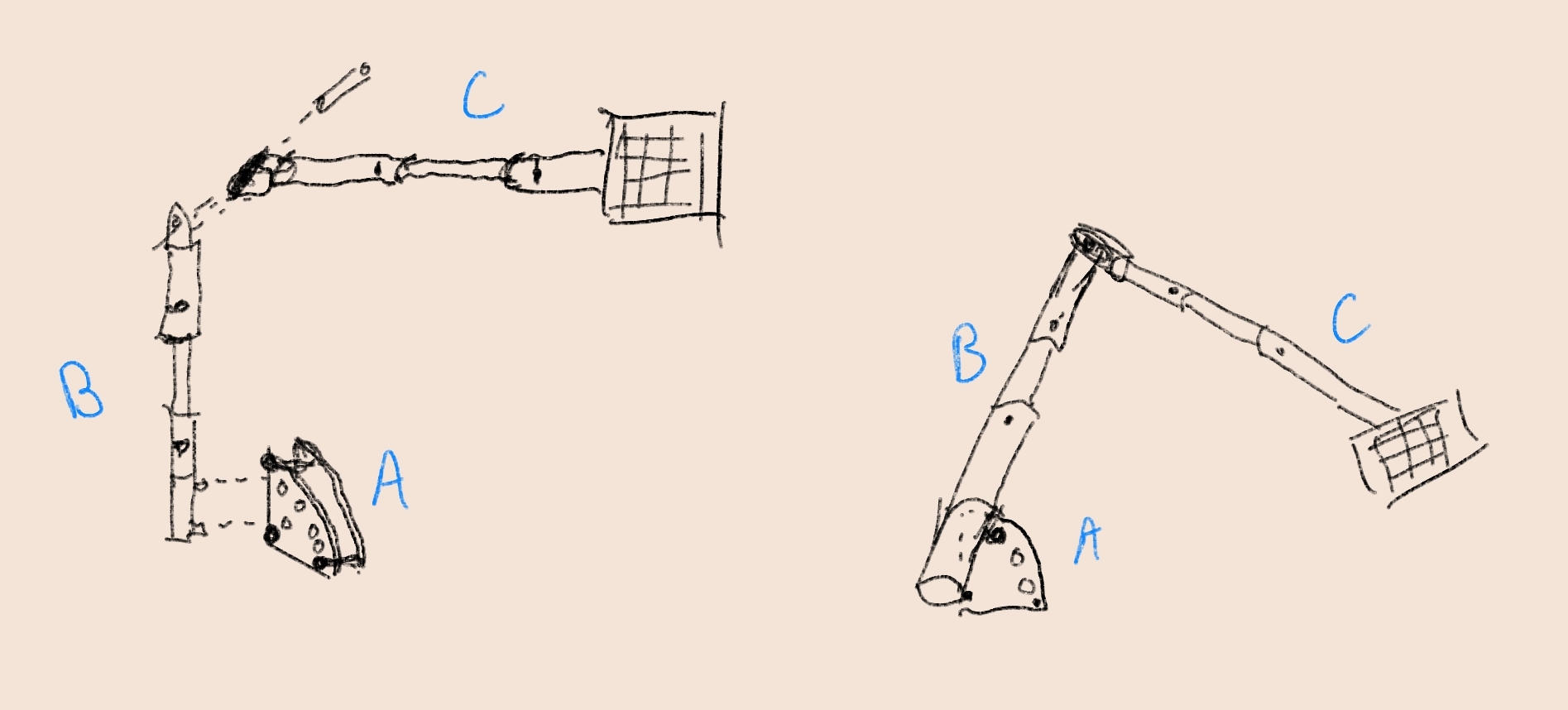


Figure 9. Prototype’s Design #2

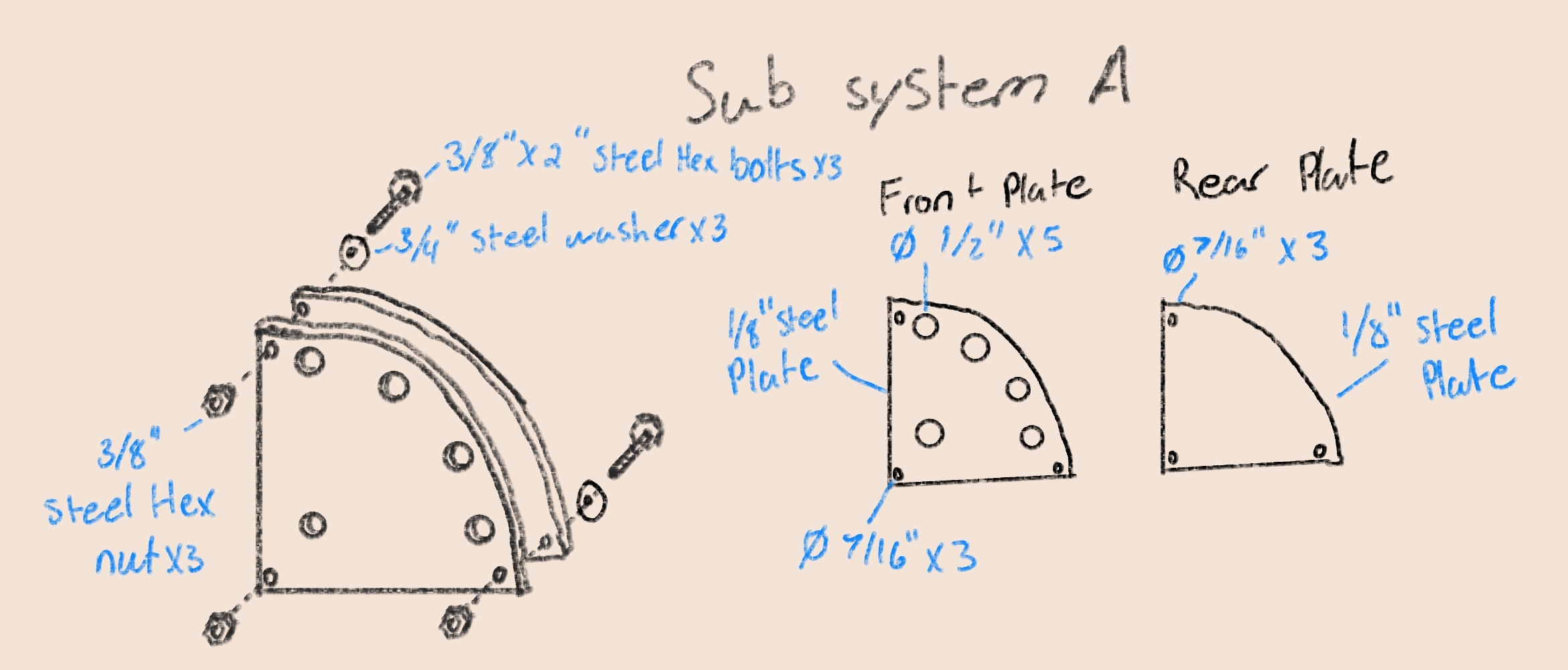
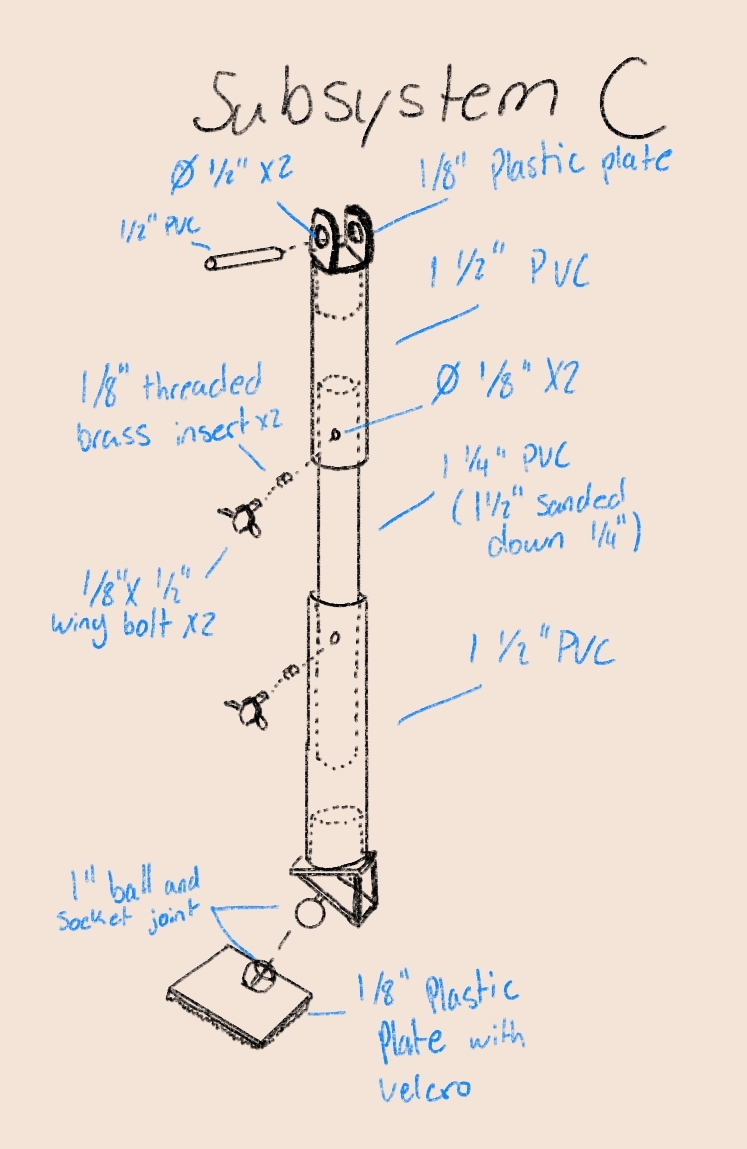
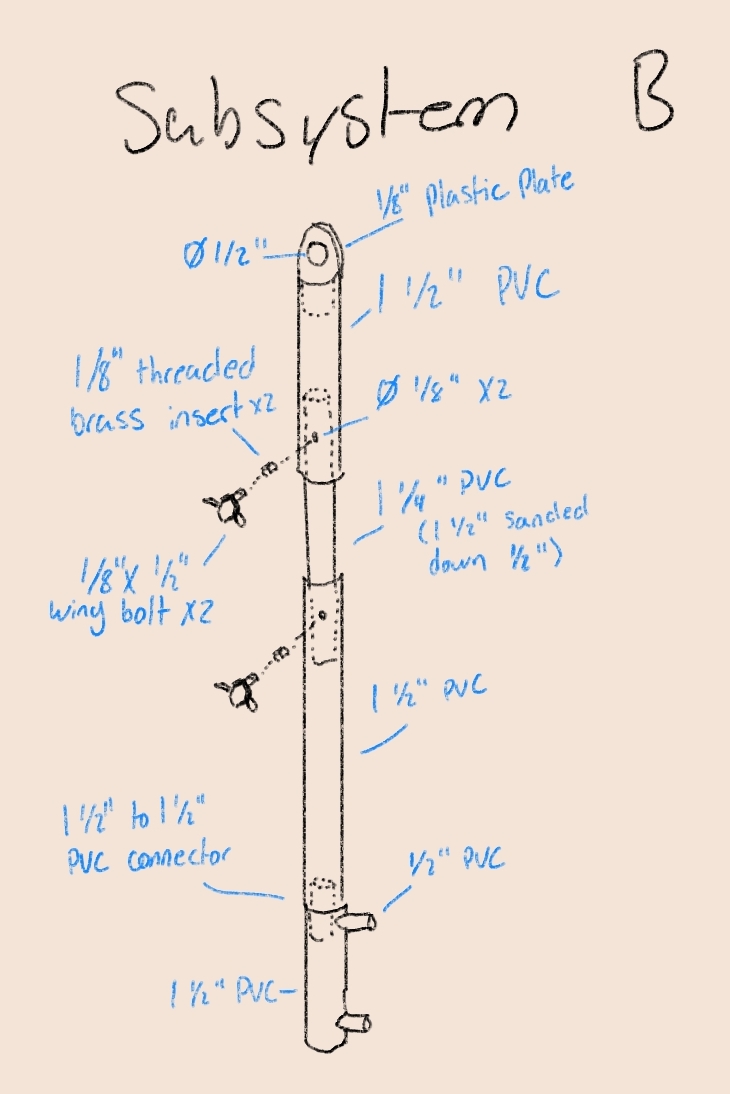
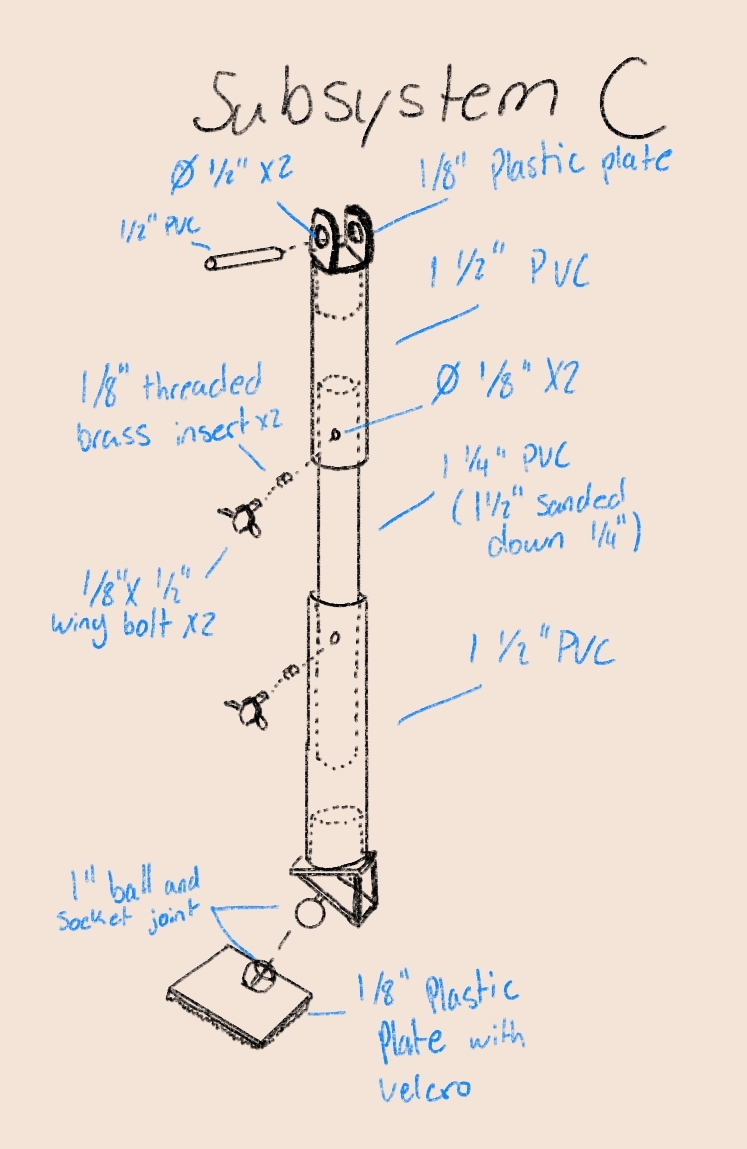


Figure 10. Prototype’s Design #3





## BOM

Table 10. First BOM

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Item name | Description | Unit of measure | Quantity | Unit cost | Extended cost | Link |
| PVC pipe | 1 ½-inch, 6ft | Unit | 1 | $22.29 | $22.29 | [System 15 1 1/2 inch X 6 ft. PVC DWV Pipe | The Home Depot Canada](https://www.homedepot.ca/product/system-15-1-1-2-inch-x-6-ft-pvc-dwv-pipe/1001101784) |
| PVC pipe elbow | 1 ½-inch, 90d | Unit | 1 | $6.97 | $6.97 | [System 15 1 1/2 inch x 90d Pvc DWV Short Hxh | The Home Depot Canada](https://www.homedepot.ca/product/system-15-1-1-2-inch-x-90d-pvc-dwv-short-hxh/1001011834) |
| Velcro | 3 ½-inch Strips | Unit | 1 | $4.35 | $4.35 | [VELCRO 3 1/2-inch Strips | The Home Depot Canada](https://www.homedepot.ca/product/velcro-3-1-2-inch-strips/1000125559) |
| Steal  sheet | 6 x 18-inch, 16 Gauge | Unit | 1 / 3 | $11.97 | $3.99 | [Paulin 6 x 18-inch 16 Gauge Steel Sheet | The Home Depot Canada](https://www.homedepot.ca/product/paulin-6-x-18-inch-16-gauge-steel-sheet/1000861865) |
| PVC pipe | ½-inch, 10 ft (only need 1ft) | Unit | 1 / 10 | $12.98 | $1.30 | [IPEX HomeRite Products PVC 1/2 inches x 10 ft SCHEDULE 40 PLAIN END PIPE | The Home Depot Canada](https://www.homedepot.ca/product/ipex-homerite-products-pvc-1-2-inches-x-10-ft-schedule-40-plain-end-pipe/1000100828) |
| Plastic board | 18 x 24-inch | Unit | 1 / 3 | $12.98 | $4.33 | [Plaskolite 18-inch x 24-inch Corrugated Plastic Sheet | The Home Depot Canada](https://www.homedepot.ca/product/plaskolite-18-inch-x-24-inch-corrugated-plastic-sheet/1000171720) |
| Total product cost (without taxes or shipping) | | | | | $43.23 |  |
| Total product cost (including taxes and shipping) | | | | | $48.85 + $0 shipping |  |

## Project plan update

Because we got Wrike late on the project, it isn’t as detailed as we planned on making it for the upcoming deliverables, as most of the work was done by the time we got Wrike access.

<https://www.wrike.com/frontend/ganttchart/index.html?snapshotId=s38bL0fgCMSpvNswqxpbTEZxTCsIxqWI%7CIE2DSNZVHA2DELSTGIYA>

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

## Prototype 1

See PowerPoint presentation below.

## Project Progress Presentation

<https://uottawa-my.sharepoint.com/personal/shoan021_uottawa_ca/Documents/SMIJ%20Tech%20Progress%20Report.pptx?d=w0163f4979aa64a6e8d57d5c30f016032&csf=1&web=1&e=8JJ2F1>

## Project plan update

<https://www.wrike.com/frontend/ganttchart/index.html?snapshotId=WvQsKSc8b1e9FbLzRgbDhetIn8n4BHZK%7CIE2DSNZVHA2DELSTGIYA>

# Design Constraints and Prototype 2

## Design Constraints

The first non-functional design constraint is time. One of the main challenges of this course is being able to organize the team’s time well and complete the final prototype before design day. This allows just around 2 months of design, prototyping, testing, and building of the final product, which is very short. Each team member’s ability to dedicate time to project work is determined based on their schedule that week and where in the exam season we are. This has an impact on our design as it forces the team to write off ideas that would prolong the process and add extra loads of work that none of us have the time to complete.

The second non-functional design constraint is budget. Each team was given a different budget based on the complexity of their project, and our assigned budget is 50$. With a tight budget, our ability to get very creative with our design is limited as we don’t have access to as many resources and supplies. In addition, it creates extra stress of ensuring we don’t go over budget as we have minimal control over material costs, and there are only so many options one can choose to maintain our promise to make a strong, sturdy final product. For example, our team has decided that the main material we will use for our final prototype will be PVC. Unfortunately, PVC typically is retailed at 30$/10ft, which leaves us with a remaining budget of 20$.  That remaining budget must cover all other manufacturing expenses, which can be limiting in a project such as this.

## Abiding by Constraints

To manage our first constraint, that being time, our group is very communicative about our schedules, and we always work to accommodate each other. Some weeks, different team members will take on different loads of work to help others that may have to prioritize exam preparation over deliverable work. In addition, we ensure that we don’t create designs that are too complicated to complete in a timely manner. Thankfully, a member of our team is very skilled in machining and working with various tools to create metal parts. This will aid in the speed and efficiency of creating the bottom support of our bed mount. In addition, we have a very clear idea of how we plan to go about creating our product, and this will aid in speeding up the process as well.

With any engineering project, budget will always be a concern as companies would like to spend as little as possible to get the best out of their design and final product. With a very tight budget, at around $50, we’ve done our best to limit the materials we need and ensure that whatever must be purchased is easy to find. One solution to our problem was to collaborate with the other group working on the phone bed mount project and split the price of PVC. This will greatly benefit both teams as we will save both money and resources, ensuring there is minimal waste if the two teams split the materials.

## Proof of Effectiveness of Constraints

Time crunch can negatively affect projects like our own. According to Adobe Communication Team, having a good time management plan will have many positive outcomes for a team and their project. For example, when timelines have been mapped out effectively, stress within the group decreases. This is why formulating accurate time estimates of how long tasks will take will be able to relieve pressure across the team. Also, managing time well can increase productivity by allowing the team to prioritize certain tasks, giving the team a sense of control and direction. By using an application like Wrike to organize and plan our time, we can meet goals and reduce the risk of falling behind in our deliverables.

As mentioned before, we will be buying PVC with the other team that is also creating a phone bed mount so that we may split the cost with them. Buying materials in bulk is much cheaper than only buying exactly what we need, so collaborating with another group will reduce the cost overall, keeping us within our budget. As an example, The Home Depot is selling a 5-foot-long piece of PVC piping for $24.56. However, they are also selling a 10-foot-long piece of the same PVC for only $48.96. If both our groups were to gather our resources and purchase one 10-foot piece instead of two 5-foot pieces, both our teams would be able to save money. In addition, most hardware stores do not sell PVC piping in small quantities suitable for our projects. By collaborating, it will be easier to buy only what we need and not overspend where we don’t have to.

## Prototype 2

The first critical product assumption that the team has made is that the prototype design will function without any tests. Our design is centered around clamping the phone mount to the railing of the bed.  Without testing on the client's bed, it is difficult to be sure that the prototype will function as intended and be secure.

Another critical assumption is that the materials needed will be readily available when it is time to assemble our final prototype. Since materials can come in and out of stock at certain retailers, there is always a small chance the materials needed may not be available at the time required.  Because of the time constraint on this project, this may cause the team to switch materials of the design close to the deadline.

**Plan for Next Client Meeting**

At our next client meeting, we will present our first and second prototypes to the client. We will explain to the client our design processes for both products and present the pros and cons of each. We will also explain what changes we decided to make to the first prototype to develop the second one. Our main goal from this client meeting is to receive feedback from the client, and so that will be what we focus most of our time on.

There are also some questions that we would like to ask the client at this meeting. For example, on which side of the bed does the client lie (on the left/right side or in the middle)? Another question would be where is the client’s head positioned? What angle is their head at and how elevated is their head? To add, how far away from your phone would you like to be? These questions will help us ensure that our product will perfectly accommodate our client. Finally, we will ask the client if they have any additional concerns about the design we selected.

## Updated BOM

**BILL OF MATERIALS**

Table 11. Second BOM

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Part Description** | **Unit Price** | **Quantity** | **Cost ($)** | **Product URL** |
| PVC Pipe 1 ½’’ | $ 1.30/ft | 10 | 12.98 | <https://www.homedepot.ca/product/system-15-1-1-2-inch-x-6-ft-pvc-dwv-pipe/1001101784> |
| PVC Pipe  1¼’’ | $ 2.27/ft | 10 | 23.47 | <https://www.homedepot.ca/product/carlon-schedule-40-grey-pvc-conduit-1-1-4-in-x-10-ft-/1000101181> |
| ⅜  steel hex bolts | $ 1.59 | 3 | 3.18 | <https://www.homedepot.ca/product/paulin-3-8-16-x-3-inch-hex-head-cap-screw-18-8-stainless-steel-unc/1000131537> |
| ⅜ Nuts (general) | $ 0.30 | 7 | 2.10 | <https://www.homedepot.ca/product/paulin-3-8-16-inch-finished-hex-nut-grade-2-oversized-hot-dipped-galvanized-unc/1000135051> |
| ⅜ Washer | $ 0.20 | 3 | 0.60 | <https://www.homedepot.ca/product/paulin-1-inch-plain-steel-washers-zinc-plated-1pc/1000122566> |
| 16 Guage Plate Steel | $ 12.93 / sq ft | 2 | 25.86 | <https://www.homedepot.ca/product/paulin-12-x-24-inch-16-gauge-steel-sheet/1000861862> |
| Velcro | $ 15.00 | 1 | $15.00 | <https://www.amazon.ca/EOTW-Adhesive-Reusable-Mounting-Removable/dp/B07C8BKMLL/ref=sr_1_4_sspa?keywords=velcro&qid=1699995392&sr=8-4-spons&sp_csd=d2lkZ2V0TmFtZT1zcF9hdGY&th=1> |

TOTAL COST: **$83.19**

If PVC is split with the other team, total cost will be **$64.965.**

We are aware that our calculated BOM total is over budget. We anticipate being able to cut some costs after discussing alternative options with the TA/PM.

## Project plan update

[wrike.link.deliverableF](https://www.wrike.com/frontend/ganttchart/index.html?snapshotId=epYTwTh8s6SP9JACRhGhFWxvRP0yeQ7x%7CIE2DSNZVHA2DELSTGIYA)

# Other Considerations

## Economics report

Table 12. Cost Estimation

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| $ | Cost | Material/Labor/Expense | Fixed/Variable/  Semi-variable | Direct/Indirect |
| 1438/year | Advertising | Expense | Fixed | Indirect |
| 7800/year | Electricity and heating | Expense | Fixed | Indirect |
| 191,086/year | Labour (Production) | Labor | Variable | Direct |
| 1,911/year | Staff training | Expense | Variable | Indirect |
| 12,240/year | Rent | Expense | Fixed | Indirect |
| 398,376/year | Production materials | Material | Variable | Direct |
| 23,524 in the 1st year | Production equipment | Expense | Fixed & Variable | Direct |
| 8,000/year | Overhead | Expense | Semi-variable | Indirect |

**3-Year Income Statement**

**SMIJ Tech**

**Income Statement**

2024 2025 2026

Sales Revenue $697,410 $697,410 $697,410

Cost of Goods Sold

Production Material 398,376 398,376 398,376

Labour 191,086 191,086 191,086

Total Cost of Goods Sold 589,462 589,462 589,462

**Gross Profit**   **$107,948 $107,948 $107,948**

Operating Expenses

Production Equipment 23,524 - -

Rent 12,240 12,240 12,240

Overhead 8,000 8,000 8,000

Electricity and Heating 7,800 7,800 7,800

Staff Training 1,911 1,911 1,911

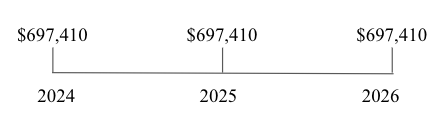
Advertising 1,438 1,438 1,438

Total Operating Expenses 54,913 31,389 31,389

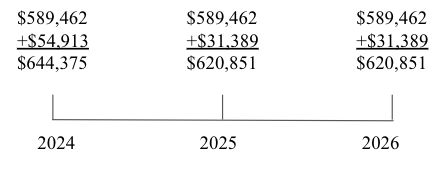
**Operating Income $53,035 $76,559 $76,559**

**Break Even Point and Cash Flow Diagrams**

Incomes:



Expenses:



NPV Values:

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

NPV (Operating Expense) = Σ[FV/(1+i)n]

NPV (Operating Expense) = ($54,913)/(1 + 0.0825)0 + ($31,389)/(1 + 0.0825)1 + ($31,389)/(1 + 0.0825)2

NPV (Operating Expense) = $54,913 + $28,996.77 + $26,786.85

NPV (Operating Expense) = $110,696.62

NPV (Production Equipment) = $23,524/(1 + 0.0825)0  = $23,524

NPV (Rent) = $12,240/(1 + 0.0825)0 + $12,240/(1 + 0.0825)1 + $12,240/(1 + 0.0825)2

NPV (Rent) ≅ $33,992.57

NPV (Overhead) = $8,000/(1 + 0.0825)0 + $8,000/(1 + 0.0825)1 + $8,000/(1 + 0.0825)2

NPV (Overhead) ≅ $22,217.37

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) ≅ $21,661.93

NPV (Staff Training) = $1,911/(1 + 0.0825)0 + $1,911/(1 + 0.0825)1 + $1,911/(1 + 0.0825)2

NPV (Staff Training) ≅ $5,307.17

NPV (Advertising) = $1,438/(1 + 0.0825)0 + $1,438/(1 + 0.0825)1 + $1,438/(1 + 0.0825)2

NPV (Advertising) ≅ $3,993.57

Selling Price Per Unit = $90/unit

Material Cost Per Unit = $51.41/unit

Labour Cost Per Unit = $191,086/(7,749 units) ≅ $24.66/unit

NPV Average Selling Price = [$90/(1 + 0.0825)0 + $90/(1 + 0.0825)1 + $90/(1 + 0.0825)2]/3

NPV Average Selling Price ≅ $83.32/unit

NPV Average Material Cost Per Unit = [$51.41/(1 + 0.0825)0 + $51.41/(1 + 0.0825)1 + $51.41/(1 + 0.0825)2]/3

NPV Average Selling Price ≅ $47.59/unit

NPV Average Labour Cost Per Unit = [$24.66/(1 + 0.0825)0 + $24.66/(1 + 0.0825)1 + $24.66/(1 + 0.0825)2]/3

NPV Average Selling Price ≅ $22.83/unit

Break-Even Point:

Break-Even Point = Operating Expenses/(Price/Unit - Material Cost/Unit - Labour Cost/Unit)

Break-Even Point = $110,696.62/($83.32/unit - $47.59/unit - $22.83/unit)

Break-Even Point = 8,581.13 units

Break-Even Point ≅ 8,582 units

Therefore, the break-even point based on three years of expenses is 8,582 units.

**Assumptions**

1) Demand and Revenue: We plan to sell our product Canada-wide. Approximately, 2.7 million Canadians over the age of 15 have a mobility disability (Statistics Canada, 2020). About 57.4% of Canadians with mobility disabilities require workplace accommodations, such as aids or assistive tools and devices (Statistics Canada, 2020). As a small business, we aim to target and sell to about 0.5% of this population who use aids or assistive tools and devices in their everyday lives each year. We expect the customizability of our product to help our product appeal to more customers with different mobility needs.

(2.7 million Canadians)\*(57.4%)\*(0.5%) = 7,749 products sold per year

Our unit selling price is $90 per unit. Oftentimes, the cost of mobility aids in Canada is covered in part by the government. For example, in Ontario, the government will cover the cost of assistive equipment for people with physical disabilities (Government of Canada, 2022). This means that consumers in Ontario will only pay $22.50 out of pocket for our product. This is a comparable price to device stands designed for people without disabilities. For example, on Amazon, a device stand is currently being sold for $19.99 (Amazon, n.d.).

Therefore, our estimated annual sales revenue is ($90/unit)\*(7,749 units) = $697,410

2) Material Cost: Our prototype costs $70.43 per unit. Purchasing materials in bulk will allow us to save on average about 27% on the cost of materials (Davis, 2023). This will reduce our per-unit material cost to approximately $51.41.

($70.43 per unit)\*(1-0.27) ≅ $51.41 per unit

($51.41 per unit)\*(7,749 units) = $398,376.09 ≅ $398,376

3) Labour Cost: We plan to produce about 7,749 units per year. If each employee can produce 5 units each day and there are 251 working days each year, our company will hire 5 full-time employees. We will pay each employee the Ontario minimum wage of $16.55 per hour in addition to the standard 15% employee benefit (MaRS Startup Toolkit, 2021).

[(7749 units per year)/(251 working days a year)]\*(5 units produced per day per employee) ≅ 5 full time employees

(8 hours per day)\*(251 days per year)\*($16.55/hour)\*(1.15)\*(5 employees) ≅ $191,086

4) Electricity and Heating Expenses: The average monthly electricity cost incurred by a small business is $650. Therefore, our annual electricity and heating expenses will be about $7800 (Constellation, 2022).

$650 per month(12 months) = $7800

5) Rent: The average rental rate for our factory and warehouse space is $0.85 per square foot per month. To rent a 1200-square-foot workspace will cost us approximately $12,240 per year (Prologis, 2023).

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

6) Overhead: Overhead costs include expenses such as office supplies and insurance (The Investopedia Team, 2022). Our overhead cost, not including the cost of rent, electricity and advertising, will be approximately $8000 annually.

7) Advertising: We will primarily use social media marketing to advertise to our customers. For example, the average cost per 1000 impressions on the social media platform on Facebook is $7.19 (Nutshell, 2023). To reach 200,000 potential customers each year we will spend $1,438 on advertising each year.

8) Staff Training: We aim to spend about 1% of salary costs on employee training to align with industry standards. Therefore, our estimated salary expense will be $1911 (American Express, 2019).

($191,086 salary expense)\*(1%) ≅ $1911

9) Production Equipment: We will need 4 of each machine, including a press brake ($2,965.83), a drill press ($896), a 3D printer ($449.0), a laser cutter ($1,495.20), and a saw ($74.99) for the production of our product. In total, this equates to $23,524.

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## Intellectual property report

**Related Intellectual properties**

Hospital bed phone mounting plate

[Hospital-bed phone mounting plate - ROSTEN; WILLIAM J. (freepatentsonline.com)](https://www.freepatentsonline.com/4602755.html)

This United States patent is for a phone mounting plate that is intended to be attached to a hospital bed, which is similar to the bed of our client. The product permits a swinging movement so that as the head of the bed is raised or lowered, the phone will remain continuously in a vertical plane even though the phone-mounting plate is pivoted along with the head portion of the bed. This design has similarities to our own as they both can adjust the angle of the plate that the phone is directly attached to.

Improved device for holding a phone

[Patent 3166806 Summary - Canadian Patents Database (ic.gc.ca)](https://www.ic.gc.ca/opic-cipo/cpd/eng/patent/3166806/summary.html?query=phone+mount&type=basic_search)

This Canadian patent is for a phone mount intended to be used while driving a vehicle. One of its features includes a telescoping rod for the length of the mount and a ball joint at the base of the telescoping rod. These elements are very similar to some of the components used in our own design. However, there are still some differences, including how their ball joint is at the base of the system, while ours is located at the end of the system, near the phone.

**Importance of Intellectual Properties**

Explain the importance of these intellectual properties and the legal constraints they place on developing your product or business.

Intellectual properties are important to help protect your ideas from other people copying them. This can be inventions, computer software, trademarks, literary, artistic, musical or visual works, expertise or know-how. In our case, the intellectual properties that we are focusing our attention on are inventions and product designs. Both intellectual properties above are patents, which are temporary limited legal rights granted to an inventor by a government to prevent others from copying their idea. Patents are important because they promote the sharing of innovative technological information.

For our product and business, this means that we legally cannot manufacture, sell, or use their invention for our own profits. We must remain conscious of this when developing our product. However, even though both our product and the patented ideas have some similarities, they are not similar enough to induce patent infringement. To elaborate, the “hospital bed phone mounting plate” adjusts the angle automatically, using electronics. Whereas our mount is to be adjusted manually. Also, the “improved device for holding a phone” uses both a telescoping rod and a ball joint, like our design. However, these parts are used in different ways for slightly different purposes, rendering our idea not too similar to theirs.

## Project plan update

[wrike.link.deliverableG](https://www.wrike.com/frontend/ganttchart/index.html?snapshotId=ectBD2EMrQDisAnOdr1FEv5ElkGzXMPE%7CIE2DSNZVHA2DELSTGIYA)

# Design Day Pitch and Final Prototype Evaluation

Rough Pitch: Now every strong project begins with a strong base, which is why the base of our phone mount is made of two 16-gauge steel plates: bulletproof. Although the product was designed with the client's specific situation in mind, adjustability and versatility are the name of the game, and we did not shy away from packing our design with as many adjustable features as possible. The base plate can accommodate any two-rail system from 4.5" inner spacing to 10" outer spacing. The hole array allows for four fixed positions that the mount can sit in, as well as quick removal of the arm. Hidden behind the wing-bolt setscrews are the telescoping and rotational features of the arms. Each arm can telescope out by 8" and has 360 degrees of rotation allowing for infinite position ability to cater to any situation. The elbow joint between the arms allows the hanging arm to be raised and lowered as the user pleases. The ball joint attached to the Velcro plate allows for fine-tuned positioning of the phone orientation. The rotation allows the arm to pivot flat against the wall to be quickly relocated, and the entire arm can collapse down to minimize its footprint for storage.

# Video and User Manual

## Video pitch

[video demo.mp4](https://uottawa-my.sharepoint.com/personal/imitc083_uottawa_ca/Documents/video%20demo.mp4?csf=1&web=1&e=iEVQ3X)

## User manual

See separate document for User Manual.

# Conclusions

These are some tricks and methods that we followed to complete the phone bed mount prototype. To start, having and maintaining a solid schedule really helped our group succeed. Dividing up the tasks early in the week and each member of the team's commitment to those plans ensured that we could finish all our work on time while being able to produce quality results. Good communication was another element that kept us all on the right track. This practice allowed us to coordinate our efforts, track our progress, and quickly problem-solve. Throughout the development of our prototype, we assigned tasks to each team member depending on their current skills and expertise. This helped us optimize our time and be as productive as possible. However, this strategy did not allow much room for people to try different things and to learn new skills. If we had had more time to work on our prototype, we would have purposefully assigned tasks so that each team member could have more of an opportunity to learn different skills. For example, our software engineer member could have tried to use solid works. Also, members who don’t know how to machine could have gotten a chance to try to machine some parts.

In all, we learned that it takes a lot of time and planning to be able to develop a potentially successful. There are many complexities to development that render the process to be less like a straight line, and more like many loops and iterations. Because of this, we learned that seemingly negative setbacks can lead to new and innovative ideas. Every step is a part of the design process and leads us to our final prototype, even the problems and issues we faced. Ultimately, we were able to develop and create our final phone bed mount prototype that all the team members are proud of.