

**GNG2101**  
**User Manual**

**SMIJ TECH B 1.3**

Submitted by: December 10<sup>th</sup>, 2023

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November 20, 2023

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# List of Acronyms and Glossary

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Table 1. Acronyms

Acronym	Definition
UPM	User and Product Manual
BOM	Bill of Materials
PVC	Polyvinyl chloride

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# 1 Introduction

This User and Product Manual (UPM) provides the information necessary for differently-abled persons and their caregivers to use our phone bed mount effectively and for prototype documentation. This product is mostly tailored toward users who face challenges in arm and hand mobility. A critical assumption of our product is that users will have a bed that has bed rails on the frame, and they will have a caregiver available to help them with the set-up and adjustment of the mount.

The purpose of this document is to provide users and technicians with guidelines and detailed descriptions of our product, to increase our product's ease of use. This manual will outline the features and functions of the system, subsystems, its setup, as well as directions of use. First, we will cover the general set-up of the system, including its accessibility and the exiting of the system. Next, we will cover each function of the mount and outline clear instructions for its use. Furthermore, the support and maintenance of the system will be explained in case any issues are ever faced. Finally, our Bill of Materials (BOM) and the equipment used will be described.

In addition, this document maintains the confidentiality of our client's information and identity.

## 2 Overview

Unfortunately, many products are not tailored to the needs of the differently-abled community. We have created a product that accommodates accessibility issues that are specific to our client. The fundamental need of our user is to have a sturdy phone mount, that will hold their phone away from their arms, and is easy to push away from their bed. The device must be easy to set up, and it must accommodate their pre-existing situation, which includes their bed set-up and the Velcro attachment on their device. Our creation of this product is important as it grants our client independence in using their device, as well as comfort as it accommodates them and their accessibility requirements.

### **Problem Statement:**

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

What makes our phone bed mount stand out from others is its simplicity, while still being safe to use, efficient, and checking off all boxes outlined by our client. Our product is very adjustable and can suspend the device in many different viewable positions. This makes our product very versatile as well as customizable to accommodate many different users' wants and needs.



Figure 1: Final Prototype of the Bed Phone Mount

The key features of our phone bed mount include the steel  $\frac{1}{4}$  circle adjustment base, providing the ability to change the angle of the mount. Next, each of the two arms is made with telescoping tubes which adds an additional element of adjustability, meaning our client can choose the height and length at which the phone mount is set up.

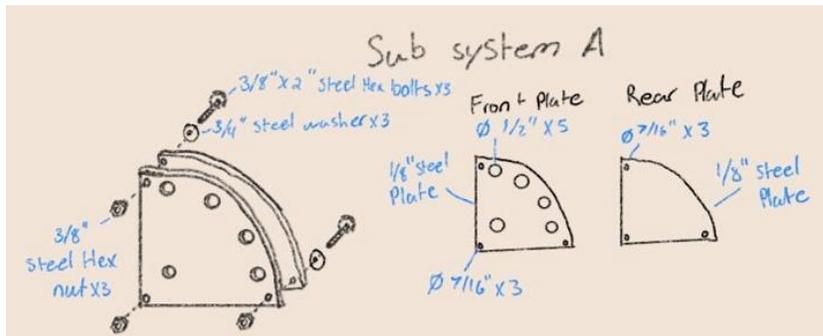


Figure 2: Detailed Design of Subsystem A

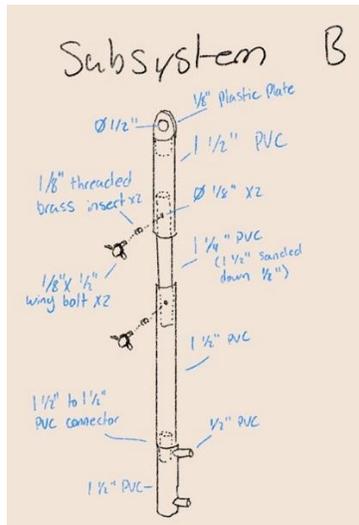


Figure 3: Detailed Design of Subsystem B

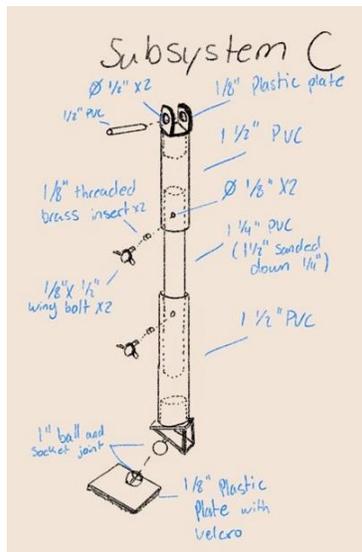


Figure 4: Detailed Design of Subsystem C

The metal base is first attached to the bed frame. It will support the mount and allow for the angle to be adjusted. Both the vertical and horizontal lengths of the mount have adjustable lengths that can extend and retract. A Velcro pad is connected to the end of the mount and can swivel to angle the device. Use a Velcro phone case to adhere the device to the Velcro pad.

Overview

## **2.1 Cautions & Warnings**

When using this mount, it is important to ensure that objects with a mass no heavier than about 500 grams are used, as the system was built with the intention of carrying an iPhone 14 Pro Max, which is what is being used by our client. Therefore, this should not be used as a support for a person to hang onto in need of balance, and it is not for a device heavier or larger than the device previously listed. With that said, the product's range of motion provides a failsafe to ensure that even if the phone is too heavy, it won't fall.

### 3 Getting started

The following section will outline the set-up of the phone bed mount, including its attachment to a bed, and some of how it can be positioned. Our product permits removability, but ideally, the main supportive component (outlined later) will remain affixed in its position.

#### 3.1 Configuration Considerations

##### Steel Base

Installation of this feature occurs on the bed rails of the client's bed. This is done with two steel plates, three hex nuts, six washers, and three bolts provided, as well as a wrench. Align the two steel plates on either side of the bed rails, with the curved edges facing outward and the two straight edges facing the ground and the head of the bed. The steel plate with more holes should be on the outer side of the rail, while the other steel plate should be on the inner side of the rail. Once the desired location is found, secure the two steel plates together with the bed rails between them using the screws, washers, and bolts in the three smallest holes in the steel plates. Each screw passes through both steel plates, with a washer on each of the outward-facing sides of the steel plates. The steel base is the only element of the product that is permanently fastened directly to the bed. It should not require to be moved or adjusted during everyday use of the phone bed mount.

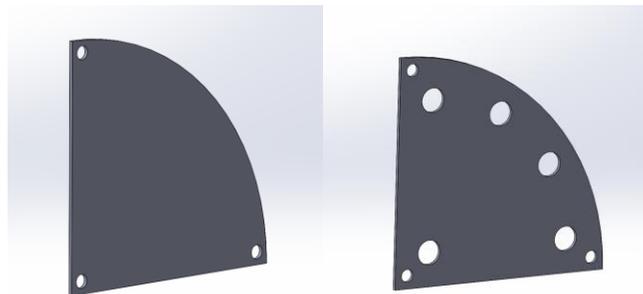


Figure 5: Steel Plate



Figure 6: Nut, Bolt, and Washer for Steel Plate

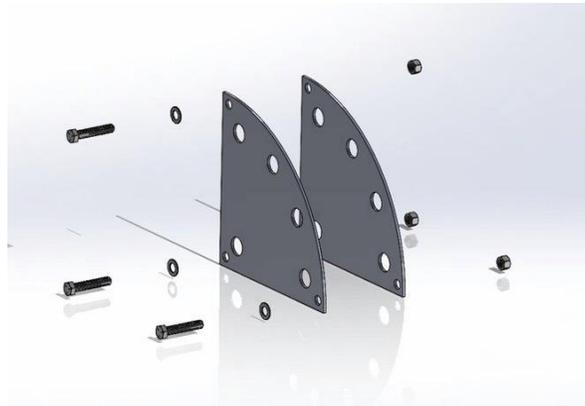


Figure 7: Assembly of Steel Base

### 3.2 User Considerations

Anyone, including people who are a part of the differently abled community, can use this prototype once it is set up and positioned to their liking. Installing the steel base could require the aid of a helper or caregiver of the client to accomplish. In addition, the client may also require some aid when adjusting the angle of their phone after the phone bed mount is configured and positioned initially. Because of these restraints, some users would need another person who could re-configure and adjust the system for them.

### 3.3 Accessing/setting up the System

#### Steel base and Vertical Arm

To set up the phone bed mount after the steel base has been attached to the bed frame, the vertical arm of the main system is to be inserted into the steel base. Place the two pegs of the vertical arm into the steel base, with one in the larger, center hole and another in one of the four larger, outer holes.

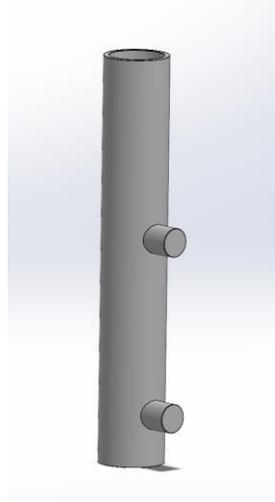


Figure 8: Piece of the Vertical Arm to be Inserted in the Steel Base

### 3.4 System Organization & Navigation

The two primary components of the mount are the steel base and the main system, with the main system being comprised of multiple subsections.

#### Steel Base

As mentioned, the steel base is the only part that is connected directly to the bed. To connect the two primary components together, the vertical arm of the main system is inserted into the steel base.

#### Main System

The main system can easily be separated from the steel base and can be removed or adjusted often. It is comprised of 3 elements, which includes the vertical arm, the horizontal arm, and the phone plate. These elements are all permanently connected to each other, with the horizontal arm being directly connected to the vertical arm on one side and the phone plate on the other.

Getting started

### **Arms**

Both the vertical and horizontal arms are comprised of 3 main elements. The center rod has a smaller radius than the two outer tubes and it fits inside the outer tubes snugly. The rods are fastened together using wing bolts.

### **Phone plate**

The phone plate is permanently attached to the horizontal arm of the main system. This is where the phone is adhered to the system using Velcro.

## **3.5 Exiting the System**

To remove the system temporarily, one can simply push the mount away from them and it will be tucked neatly to the side, neatly out of the way. If one is interested in completely removing the main system, simply remove the vertical arm from the steel base that is attached to the bed frame. If one is interested in removing the entire system (the main system and the steel base attached to the bed), a wrench is required to unscrew the metal plates from their position.

## 4 Using the System

The following subsections provide detailed, step-by-step instructions on how to use the various functions and features that allow for the phone bed mount to be adjusted and positioned. Use all these features together to orient the phone to the perfect spot.

### 4.1 Positioning of the Phone

#### 4.1.1 Steel base and Vertical Arm

As mentioned previously in section 3.3, setting up the system, it is explained that the vertical arm is to be inserted into the steel base's largest center hole and one of its four larger, outer holes. The chosen hole will affect the angle of the phone, as well as the phone's distance from the user's face. This decision can be easily altered by removing the vertical arm from the base and reinserting it, without the need for any tools.

#### 4.1.2 Vertical and Horizontal Arms

For both the vertical and horizontal arms, their lengths can be adjusted. To do this, unscrew the wing bolt until it is loose enough to be moved. Then, slide the center rod in the two outer tubes to create the desired length. Tighten the wing bolt just until secure to maintain this length. Do not crank the wing bolt too far. Some of the threading will still be exposed when fully fastened. This can be done for the wing bolts on both arms to adjust the two ends of the vertical arm and the horizontal arm.



Figure 9: Arm Assembled

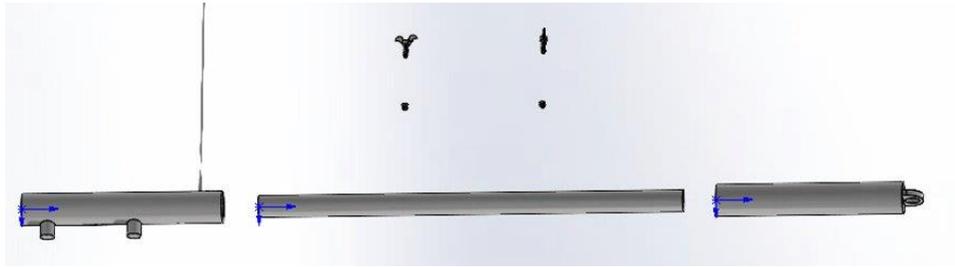


Figure 10: Arm Disassembled

Using the System

### **4.1.3 Phone Plate**

Using a phone with a Velcro phone case, stick the back of the phone to the Velcro on the phone plate. Because of the ball joint attached to the phone plate, the phone can be angled by simply adjusting the phone plate in the ball joint. The phone will remain in the chosen position, without the need for tools or screws.

## **5 Troubleshooting & Support**

### **5.1 Error Messages or Behaviors**

Over time, the vertical and horizontal arm's PVC may begin to bend due to the weight of the phone and the suspended horizontal arm. This is very unlikely though since PVC is very rigid and strong. With that said, do not place your body weight on the product, as it is only intended to support its own weight and the weight of the phone.

The ball joint connecting the phone plate to the main system may also become worn out after extensive use. If the ball joint is constantly moved, the material may become shaved down and the ball may become loose in the socket. To avoid this, only adjust the ball joint and phone plate's angle when required.

### **5.2 Special Considerations**

### **5.3 Maintenance**

This product does not require much maintenance for its everyday use. However, routine checks are recommended to ensure that none of the parts are loose or may disconnect accidentally during use. Make sure that the vertical arm is properly inserted into the steel base and that the arms' wing bolts are tightened sufficiently.

### **5.4 Support**

For system support, contact either Isaac Mitchell ([imitc083@uottawa.ca](mailto:imitc083@uottawa.ca)), Jeremy Rigley ([jrigl046@uottawa.ca](mailto:jrigl046@uottawa.ca)) Marie Levin ([mlevi020@uottawa.ca](mailto:mlevi020@uottawa.ca)), or Sophie Hoang ([shoan021@uottawa.ca](mailto:shoan021@uottawa.ca)). If a problem related to the system is identified, email one of the above-mentioned personnel with information depicting which product is experiencing an issue and details about the specific issue. However, if emergency assistance is required, contact your local authorities for immediate aid.

## 6 Product Documentation

### 6.1 Steel base

#### 6.1.1 BOM (Bill of Materials)

Table 2. Steel Base BOM

Item	Description	Qty	Cost per unit	Extended	Link
Steel Plate	12 x 24-inch 16 Gauge Steel Sheet	1	\$25.38	\$25.38	<a href="http://www.homedepot.ca/en/home/p.12-x-24-inch-16-Gauge-Steel-Sheet.1000861862.html">http://www.homedepot.ca/en/home/p.12-x-24-inch-16-Gauge-Steel-Sheet.1000861862.html</a>
Hex nuts	3/8-16 <sup>th</sup> inch finished hex nut – zinc plated – grade 5	3	\$0.27	\$0.81	<a href="http://www.homedepot.ca/en/home/p.3-8-16-inch-Finished-Hex-Nut---Zinc-Plated---Grade-5---UNC.1000123459.html">http://www.homedepot.ca/en/home/p.3-8-16-inch-Finished-Hex-Nut---Zinc-Plated---Grade-5---UNC.1000123459.html</a>
3" bolts	3/8-16X3 exterior black carriage bolt	4	\$1.29	\$5.16	<a href="http://www.homedepot.ca/en/home/p.3-8-16X3-EXTERIOR-BLACK-CARRIAGE-BOLT.1001613149.html">http://www.homedepot.ca/en/home/p.3-8-16X3-EXTERIOR-BLACK-CARRIAGE-BOLT.1001613149.html</a>
Washers	3/8 inch Flat Washer (18.8 Stainless Steel)	6	\$0.80	\$4.80	<a href="http://www.homedepot.ca/en/home/p.3-8-inch-%287-8-inch-O-D-%29-Flat-Washer--18-8-Stainless-Steel.1000182056.html">http://www.homedepot.ca/en/home/p.3-8-inch-%287-8-inch-O-D-%29-Flat-Washer--18-8-Stainless-Steel.1000182056.html</a>
Total cost (without taxes)				\$36.15	

#### 6.1.2 Equipment list

The equipment used to build the steel base consists of a press brake to cut the steel and a drill press to cut out all of the holes in the steel plates.

#### 6.1.3 Instructions

Mark the desired shape of both steel plates and all the holes for one of the steel plates on the sheets of 16-gauge steel. Use the press brake to cut out the general shape of the plate. Then, use the drill press and two different drill sizes to cut out the holes in the marked positions. File all

the edges of the steel where cuts were made to smooth out any imperfections. The parts of this subsystem are assembled during installation, as explained in section 3.1, configuration considerations.

## 6.2 Arms

### 6.2.1 BOM (Bill of Materials)

Table 3. Arms BOM

Item	Description	Qty	Cost per unit	Extended	Link
Hex nuts	3/8-16 <sup>th</sup> inch finished hex nut – zinc plated – grade 5	2	\$0.27	\$0.54	<a href="http://www.homedepot.ca/en/home/p.3-8-16-inch-Finished-Hex-Nut---Zinc-Plated---Grade-5---UNC.1000123459.html">http://www.homedepot.ca/en/home/p.3-8-16-inch-Finished-Hex-Nut---Zinc-Plated---Grade-5---UNC.1000123459.html</a>
Wing nuts	3/8-16 <sup>th</sup> inch forged steel wing nut – zinc plated	2	\$0.76	\$1.52	<a href="http://www.homedepot.ca/en/home/p.3-8-inch-16-Forged-Steel-Wing-Nut---Zinc-Plated.1000128665.html">http://www.homedepot.ca/en/home/p.3-8-inch-16-Forged-Steel-Wing-Nut---Zinc-Plated.1000128665.html</a>
PVC	1 inch x 10 ft schedule 40 plain end pipe	1/2	\$29.98	\$14.99	<a href="https://www.homedepot.ca/p/IPEX-HomeRite-Products-PVC-1-2-inches-x-10-ft-SCHEDULE-40-PLAIN-END-PIPE-The-Home-Depot-Canada">IPEX HomeRite Products PVC 1/2 inches x 10 ft SCHEDULE 40 PLAIN END PIPE   The Home Depot Canada</a>
1/2" rod	1/2 x 36 – inch steel round rod	1/3	\$16.48	\$5.49	<a href="https://www.homedepot.ca/product/paulin-1-2-x-36-inch-steel-round-rod/1000126721">https://www.homedepot.ca/product/paulin-1-2-x-36-inch-steel-round-rod/1000126721</a>
Total cost (without taxes)				\$22.54	

### 6.2.2 Equipment list

The equipment used to build the arms includes a saw to cut the PVC, a 3D printer to print the elbow joint connecting the two arms, a drill press to drill holes into the PVC, and a band saw to shape the end of a PVC pipe.

### 6.2.3 Instructions

First, cut the four PVC tubes to their proper lengths using the saw. Also, use the saw to cut the smaller rod into two pieces of the correct lengths. Next, use the drill press to drill out the holes in the PVC tubes. Use a source of heat to heat up a hex nut, to melt through the PVC, and to embed the hex nut in the wall of the PVC in the correct position. Do this twice, once for each of the PVC tubes of both of the arms. The PVC tubes will be the outer tubes on either side of the smaller rod. Screw the wing nut into the hex nut. Glue the bolt into the lowest holes of the vertical arm's PVC. Also, glue the ball joint and phone plate (built in the next section) into the farthest hole of the horizontal arm. Use the band saw to cut the vertical arm's top end to the proper shape. Finally, 3D print the joint to connect the arms and secure it to the recently cut end of the vertical arm.

## 6.3 Phone plate

### 6.3.1 BOM (Bill of Materials)

Table 4. Phone Plate BOM

Item	Description	Qty	Cost per unit	Extended	Link
Velcro	3 inch x 1.5 inch industrial strength strips (2-pack)	1	\$5.87	\$11.74	<a href="https://www.homedepot.ca/product/velcro-4-inch-x-2-inch-industrial-strength-strips-2-pack-/1000428542">https://www.homedepot.ca/product/velcro-4-inch-x-2-inch-industrial-strength-strips-2-pack-/1000428542</a>
Total cost (without taxes)				\$11.74	

### 6.3.2 Equipment list

The equipment used to build the phone plate includes a 3D printer to print the ball joint, and a laser cutter to cut out a board from wood.

### 6.3.3 Instructions

Use a laser to cut out the wooden plate that the phone will attach to. Stick two pieces of the Velcro sheets to the wooden plate. Next, 3D-print the two pieces of the ball joint together, with very little tolerance, and glue the wooden base to the flat surface of the ball joint.

## 6.4 Testing & Validation

To produce a successful final prototype, various tests had to be done to ensure proper product functionality and reliability. To start, the first tests that were done were on the materials that were chosen. Our team tested different materials for each part of our design. The main outer shell of the product is made of PVC. This is because our stress tests resulted with only slight bending as PVC cannot shatter, which is a safety benefit. In terms of “stress test”, we took samples of PVC and applied as much force onto them as we could to ensure they wouldn’t break. Because our product specifications outline that mass no heavier than around 500g should be added to the mount, we knew PVC would suit our design. This was further proven when, in our final prototype, we attached a phone (heavier than our client’s) to the mount to prove our stress tests were correct, which they were.



Figure 11: Final Check of Mount Strength

In addition, stress tests were conducted for all the 3D printed elements of our design. Large loads of stress were applied to all parts to see if there were any effects. These tests resulted in some pieces needing to be re printed in different formats with different printing specifications to increase the strength. After these modifications, they passed our stress tests. All these tests resulted in our team ensuring that we created a product that is built to be durable and long-lasting.



Figure 12: Load Test on 3D Printed Part

## **7 Conclusions and Recommendations for Future Work**

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.

Conclusions and Recommendations for Future Work