GNG2101

Introduction to Product Development and Management
for Engineers and Computer Scientist

Camera and Cellphone Mount for a Wheelchair

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Abstract

Throughout the course of this semester, we have worked on designs and prototypes iteratively to figure out what would work from those designs. After each prototype, we would make a new design and make the next prototype better to finally get to the final design ready for Design Day. For our next steps, we are planning on improving what we completed for Design Day. To be able to design and build the various prototypes we had regular meetings with our client to fit our clients' needs and to add what she deemed as important. Every meeting we got closer and closer to the desired product for our client until our final prototype where she seemed extremely happy with the product. The final touches that we need to implement are there for a longer-lasting product so the client will remain happy in the future. In the end, we had two arms, one being a gooseneck for the camera mount and one being a solid steel arm for the phone mount. We also put rotating joints so the client can position the device as she likes or store it. Another feature we added were levers to all the adjustable joints as our client said she had trouble working with screws, but that a lever connected to the screw would allow her to work with them.

To complete the device we had to follow a feasibility plan which had made each of our group members know what we were able to do technically, who was capable of doing what needed to be done. How this product could work if it were an actual business. The legal constraints we would have to follow. Where we could build and design the product and how as a group we can make the decisions we made by meeting up with each other. Once these aspects were determined we were able to complete the product more efficiently.

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Introduction

Our project is a step towards ensuring that everyone in society can successfully participate in any hobby regardless of physical ability. One thing many people take for granted is the ability to stand up and use items such as a camera tripod. However, tripods are not designed to be used from a wheelchair, and as such is hard to adjust from a sitting position, and are even harder to balance on your lap. For wheelchair users interested in photography, it would be far more convenient to have a camera mount that can attach directly to their wheelchair. Our product opens up the world of photography to wheelchair users who are largely ignored by designers that do not consider the capabilities of those different from themselves.

Our target customer base consists of wheelchair users who are interested in photography. Whether they are professional photographers or are passionate about photography as a hobby, our product is the best way to conveniently support a camera.

Our design is sturdy yet flexible, meaning you can freely position the camera however you like and the camera will remain fully supported. Levers allow any user to quickly and easily reposition different parts of the mount, and customizable parts mean that our product can be quickly and easily adapted for a variety of users. Unlike other products on the market, our design holds a camera and a cell phone and is cheaper than similar products on the market.

Main body

Final Design:

The wheelchair camera mount can be used as both a camera mount and a phone mount. This will allow the user to choose which device they want to use at any moment. It is a simple process that uses a rotating joint to either store the second arm or have it up to support the camera. Our prototype consists of two arm segments, attached by a Posi-Lock rotating joint, which allows the mount to have a range of motion of 300 degrees. This allows the arm part to close almost entirely. The lower arm segment and the clamp of the mount is attached by another Posi-Lock that also gives 300 degrees. This allows the closed arms to be stored alongside the wheelchair. For the higher arm section, we have attached a gooseneck that allows the user to place the camera closer or further from her face. A ball joint for the camera mount allows our client to point the camera in any direction, at any angle. At the top of the lower arm section, we have placed a phone mount. This is placed at an angle that is convenient for the user to see while operating the wheelchair and also has a ball joint so that it can be adjusted to each client.

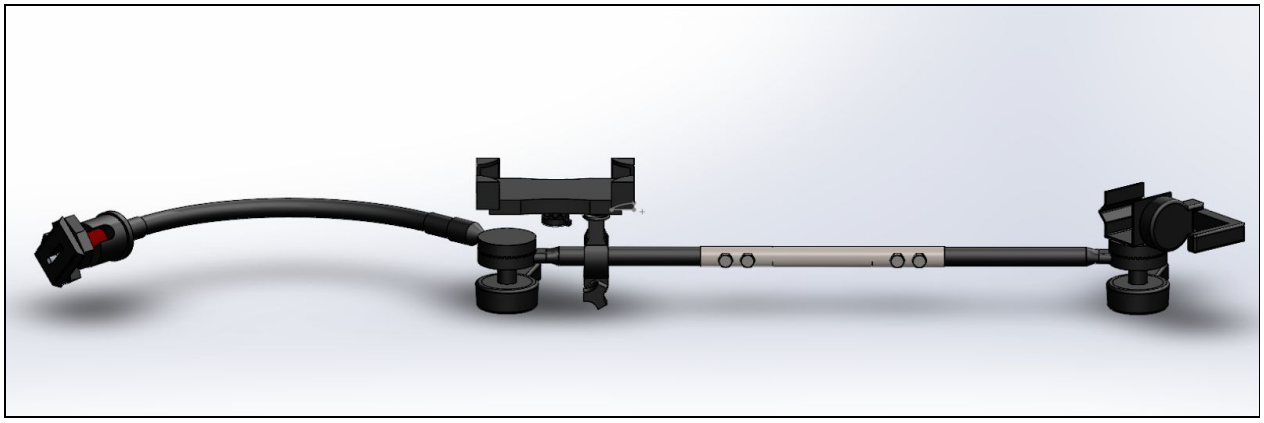


Image 1: Full Solidworks of Final Design

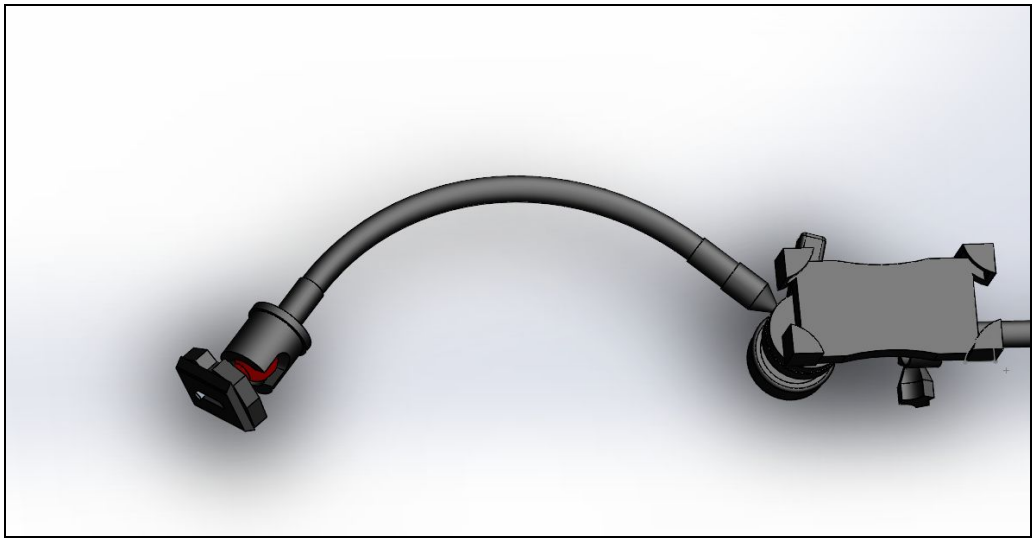


Image 2: Gooseneck, Camera Mount, and Cell phone Mount Solidworks of Final Design

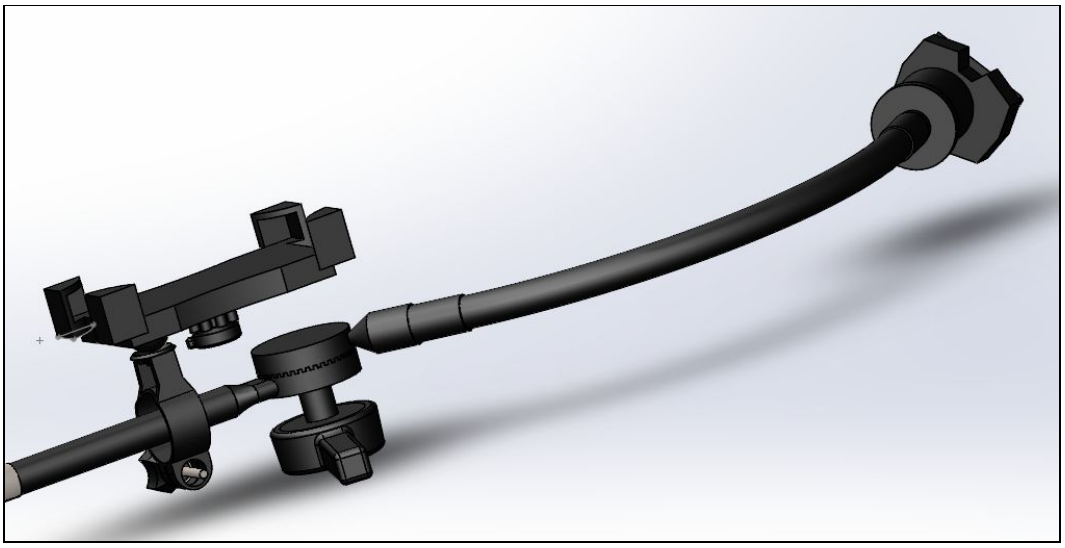


Image 3: Gooseneck, Camera Mount, and Cell phone Mount Solidworks of Final Design

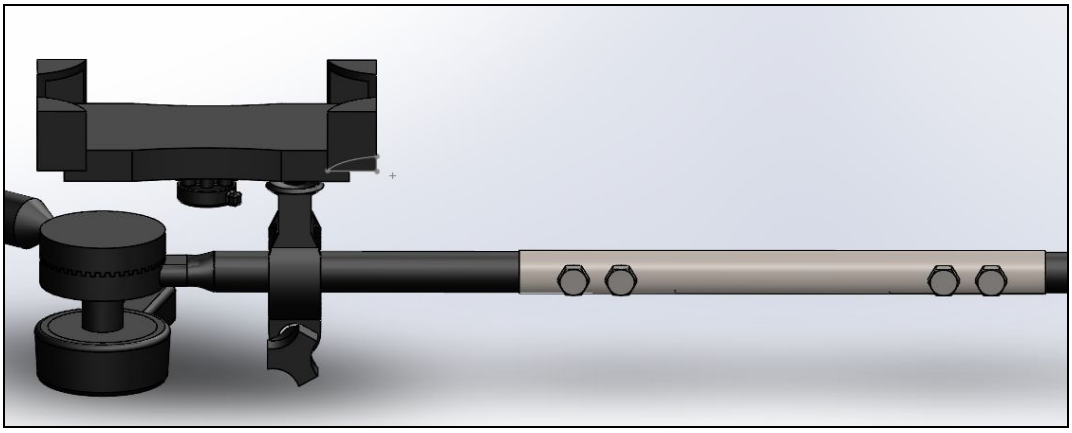


Image 4: Cell phone Mount and Arm Solidworks of Final Design

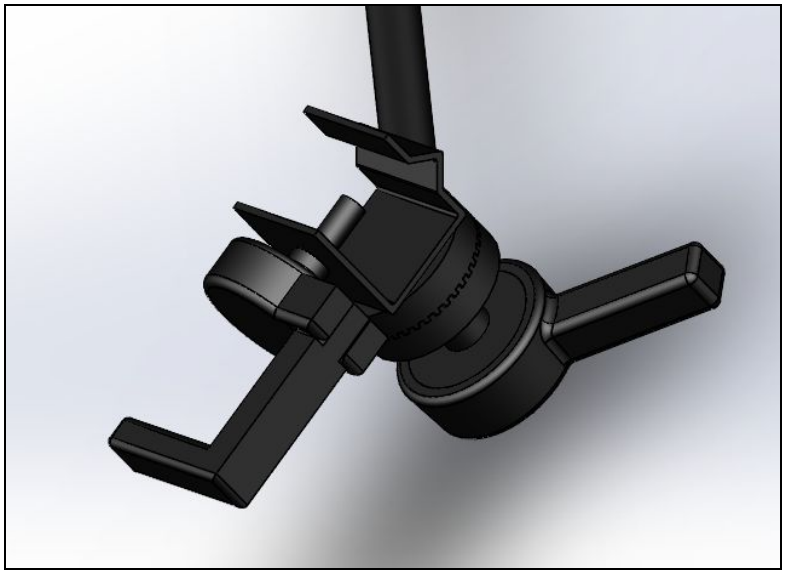


Image 5: Clamp Solidworks of Final Design

Design and Building Process

Initial Client Meeting:

Before our first client meeting, we brainstormed a variety of questions to determine who our client is and what the problem is that we will solve. Initially, our project was to build a camera mount for a wheelchair, however after meeting our client and talking with our professor, the scope of our project expanded to include a cell phone mount. From the client statements, we identified the key needs and prioritized them.

Table 1: Needs Identification

Statement	Need	Need Prioritization Client (1-5)	Need Prioritization Team (1-5)
1	The wheelchair mount is extensible so that the device can be close to the client and the angle can be adjusted	5	5
2	The wheelchair mount is sturdy and it holds the camera steady	5	4
3	The wheelchair mount is simple to set up and use. It can also be connected to any wheelchair model	4	3
4	The wheelchair mount is on the left side so it does not interfere with the remote control of the wheelchair	5	5
5	The wheelchair mount is within the wheelbase and functions normally after repeatedly bumping into objects	4	3
6	The wheelchair mount can hold a camera or a phone	3	3
7	The wheelchair mount holds the phone steady whether the chair is moving or not	3	3
8	The wheelchair mounts hold the camera steady when the wheelchair is stationary	5	5
9	The wheelchair mount is extensible so that the camera can come up to eye-level and can be lowered when client wants to drive	3	3
10	The camera platform of the wheelchair mount rotates, changes angles and moves positions easily	3	4
11	The wheelchair mount is small and lightweight	4	4

Problem Statement:

Design an adjustable camera mount to help our client do what she loves allowing her to take photos with ease.

Benchmarking:

Product	Image	Description	Price	Link
Quad-Lock Universal Adapter		The Quad-Lock Universal Adapter uses 3M™ VHB (Very High Bond) adhesive tape to secure the adapter to the phone.	$19.95	https://www.quadlockcase.ca/collections/shop-mounts/products/universal-adapter
Tecla Phone Mount		A fastener called Dual-Lock connects the stand to the phone case or the back of the phone. The neck of the stand is flexible and there is clamp.	$119.00	https://gettecla.com/products/tecla-phone-mount
Alzo Wheelchair Mount		A metal clamp fits onto any post up to 2 inches thick. The flexible arm is 12 inches long and is able to support up to 8 lb.	$222.80	https://ca-alzodigital.glopalstore.com/products/alzo-wheelchair-camera-mount?utm_campaign=pr_r&utm_source=https://www.alzodigital.com&utm_medium=wi_proxy&utm_content=en_US&utm_term=a

Table 2: Benchmarking

Target Specifications:

Metric	**Unit of Measurement**	**Target Specifications**	**Reasons for Choices**
Fully extended range of mount	Centimeters	$\geq$30 cm	To allow the user to bring it to their face
Degrees of flexibility of mount arm	Degrees	360°	To allow the user to take photos from all angles
Speed at which loaded mount moves towards the ground while chair is stationary	Meters per second	0, Does not move	The wheelchair mount should be stable
Speed at which loaded mount moves towards the ground while chair is in motion	Meters per second	0, Does not move	The wheelchair mount should be stable
Wheelchair mount can function after repeated collisions	Collisions	$\geq$100	The wheelchair mount must be durable enough to survive environmental hazards, including impacts with other objects.
Degrees of rotation for the camera platform	Degrees	360° of rotational freedom $\geq$90° of forwards tilt $\geq$60° of backwards tilt	This keeps our product at the industry standard
Force required to change camera angles/position	Newtons	≤ 20N	The force required to move the mount must be weak enough that the client can move it yet strong enough to resist gravity
Weight of wheelchair	Kilograms	$\leq$1.35 kg	The wheelchair

mount			mount should be light enough for easy transportation
Number of different kinds of wheelchairs the mount can attach to	Different wheelchair styles	≥5	The wheelchair mount must be usable by a variety of wheelchair users, or by the same user if they purchase a new wheelchair
Set up time for one person with only the instruction book	Minutes	<2 minutes	The wheelchair mount must be easy and convenient to set up and use
Manufacturing price	Canadian Dollars	<$100	The project itself must remain within budget

Table 3: Target Specifications

Initial Design:

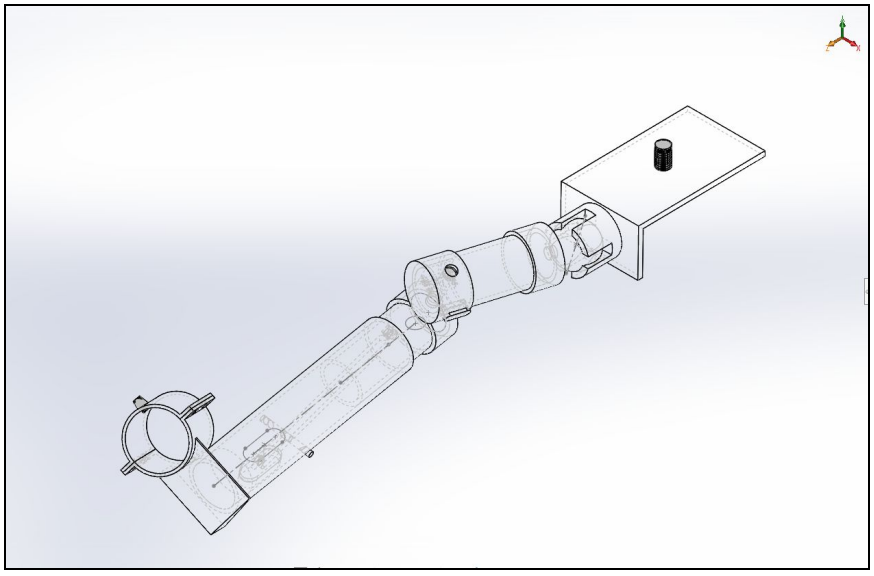


Image 6: Design 1 Solidworks

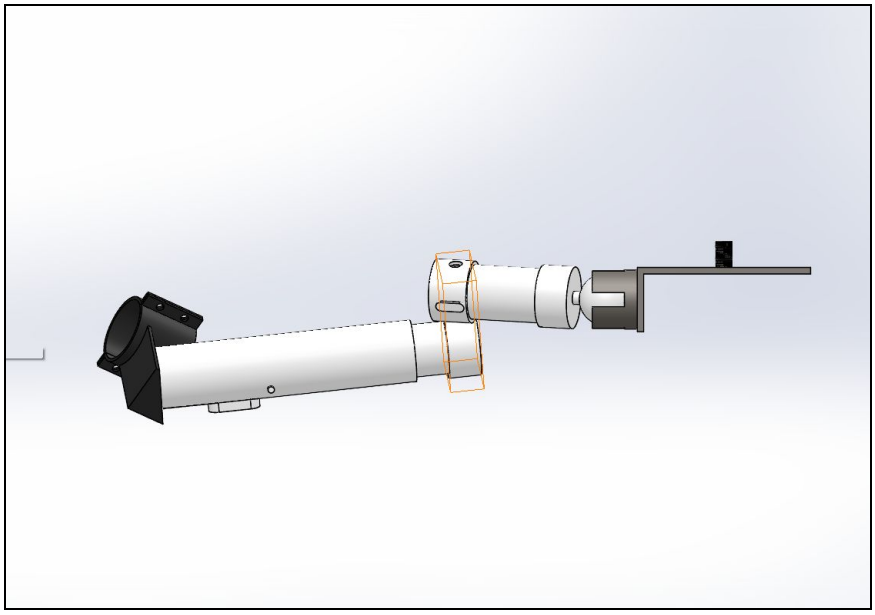


Image 7: Design 1 Solidworks

Two metal semi-cylindrical segments are connected by two small metal plates and work as a clamp onto the wheelchair. To accommodate different wheelchairs, the small metal plates can be adjusted with metal screws along the side. The clamp holds a PVC pipe with a diameter of 1 ½ inches and a length of 8 inches. There is an end cap on the top of the PVC pipe, and it is connected to a second PVC pipe with a diameter of 1 ¼ inches. The two PVC pipes are connected by an axel with a friction grip. This allows the second PVC pipe to rotate in different directions. The second PVC pipe has end caps on both ends. The top end cap of the second PVC pipe and the platform that the camera rests on is connected by a ball joint. This allows the camera to be positioned in any direction.

Feasibility Plan:

Technical: All members of the team have completed basic mill and lathe training. Nicholas has completed MIG and TIG welding training and Rachel has completed MIG welding training.

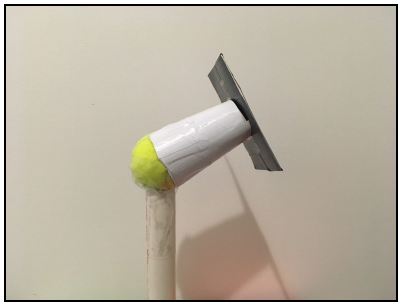
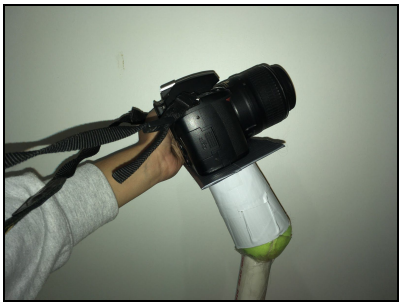
Economic: The majority of our materials were bought on Amazon and arrived quickly, but our product is over budget.

Legal: Our prototype does not closely resemble any designs we found as part of the benchmarking process.

Operational: We have completed all makerspace trainings that were relevant to our project.

Scheduling: We made weekly meetings after every class on Friday to make sure that we were all still on track. We also made separate meetings often for presentations or to build the product.

Prototype 1:


Images 8-10: Prototype 1 Camera Mount, Prototype 1 Camera Mount with Camera, Prototype 1 Clamp

For the first prototype, we added a clamp to a chair to see how it would look and if the clamp could fit through the door, which it did not so we had to figure out a way to make the clamp not extend out as much. We put a ball on the end of a stick to simulate a ball joint and we liked the idea as it worked as imagined so we put the ball joint on the final design.

Business Model:

Key Partners	Key Activities	Value Proposition	Customer Relationships	Customer Segments

- Engineering Faculty
- CEED
- Suppliers:
  - Metal Marketplace
  - CEED
  - Amazon
  - AVShop.ca
	- Group meetings
	- Labs
	- Client meetings
	- Prototype building
		- Help customers enjoy their passion of photography despite their physical limitations
		
		- Help clients through customizability
			- Good communication with client
			- Constructive feedback
				- People in wheelchairs
				- Camera companies
				- Electronic shops
				- Shop for disabled people

	Key Resources
	- Money:
	- CEED:
	  - Makerspace
	  - Brunsfield
	  - JMTS (maybe)
	- Teacher, TA, PM
			Channels
			- Home Delivery	

Cost Structure Fixed: - Software - Real-estate (depending) Variable Costs: - Materials - Manufacturing - Delivery - Real- estate (depending) Mixed: - Employees - Ads			**Revenue Streams** -Asset sales -Customized asset sales	

Design 2:

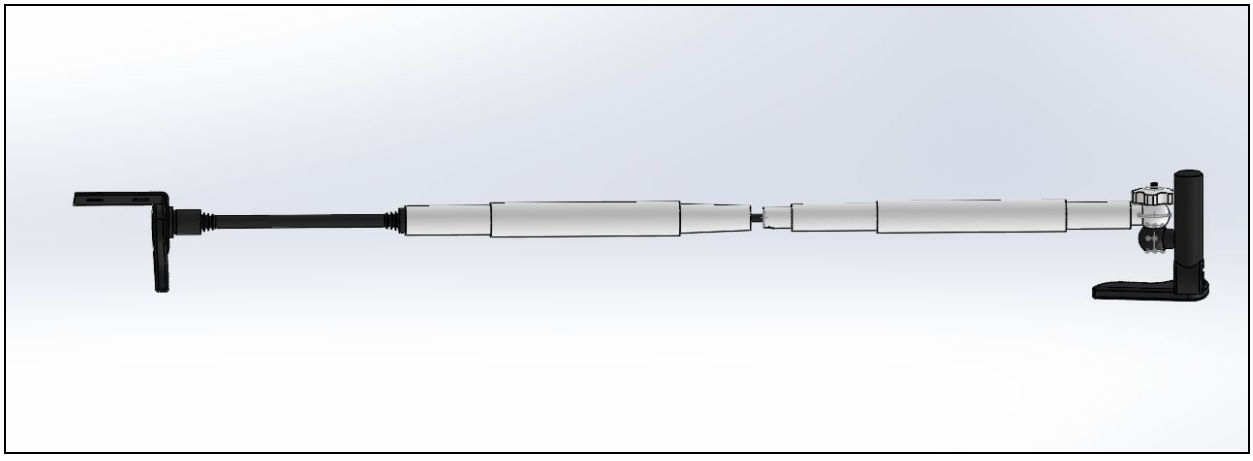


Image 11: Full Design 2 Solidworks

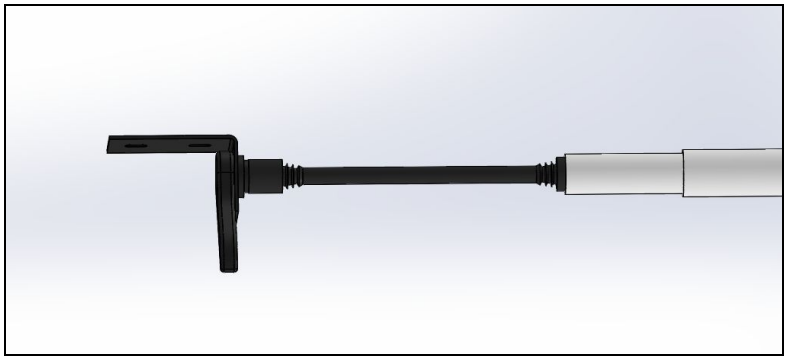


Image 12: Camera Mount Design 2 Solidworks

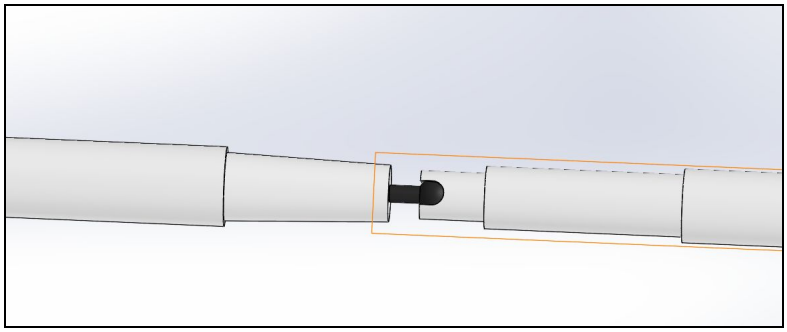


Image 13: Ball Joint Design 2 Solidworks

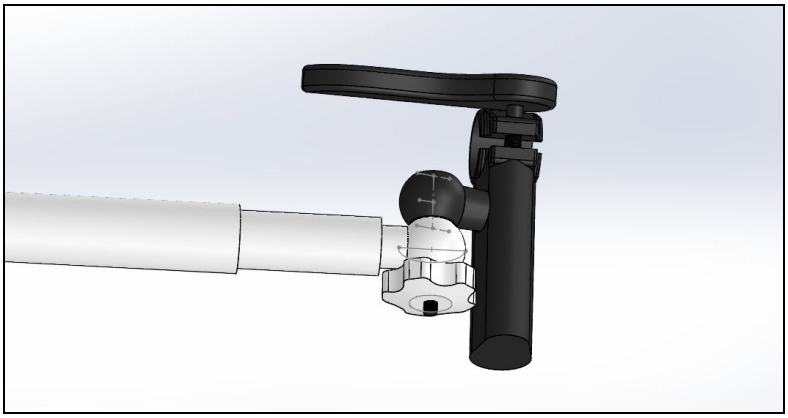


Image 14: Clamp Design 2 Solidworks

Prototype 2:

Image 15: Full Prototype 2

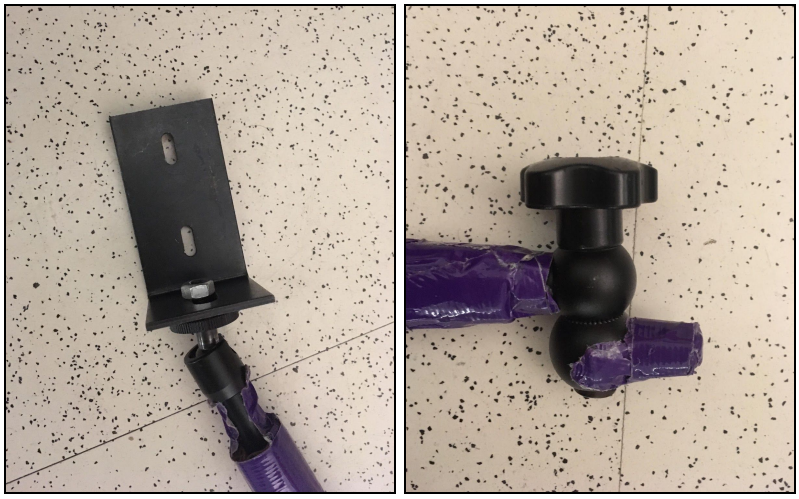


Image 16, 17: Camera Mount Prototype 2, Clamp Prototype 2

For the second prototype, we took a product that worked as a camera mount stand to attached to a wall and disassembled it to match our ideas. We sawed the arms in half to extend the range of the device and we also added a plate to have a place to put the camera. The prototype worked with a rotating hinge in the middle which was similar to our final design and a ball joint to support the camera mount which was also on the final.

How It Works:

The clamp of the product can be attached to a vertical or horizontal post on the left side of the wheelchair. Adjust the lower rotating joint to bring the phone holder to a suitable height. If only the camera mount is in use, close the rotating joint so that the upper arm is behind the lower arm. This is to ensure that the camera mount is not an inconvenience while operating the wheelchair. To attach the phone, loosen the screw at the back of the phone holder. Insert the phone into the holder, and tighten the screw. To put the camera mount in use, adjust the upper rotating joint and the gooseneck so that the camera mount can be brought to eye-level. To attach the camera, there are two options. The first option is to remove the small camera platform and secure it to the screw hole of the camera. Slide the platform into the top of the camera mount and tighten the screw. The second option is to screw the camera directly to the platform of the camera mount. Once the camera is attached, the two levers on the camera mount can be loosened to allow the ball joint to activate, giving the camera 360 degrees of rotational freedom.

Maintenance:

Our design is completely modular, meaning any part can be easily replaced. The phone mount, Posi-lock joints, gooseneck, and camera mount platform are all available on Amazon, and can all be ordered with ease. The levers attached to the Posi-lock joints are 3D-printed plastic, and files can be downloaded from our Makerepo project page and printed from either the UOttawa Makerspace or from the Ottawa Public Library.

In the unlikely event that the steel tubing holding the two Posi-lock joints together breaks, then a new part can be requisitioned from our chief manufacturing officer, Nicholas Anderson, who can be reached at the email nande029@uottawa.ca. For those with access to a lathe, a mill, and steel tubing, they can reconstruct the part themselves using specifications found in the part file on our Makerepo project page.

Health and Safety:

There are very few possible health and safety risks from our product. The only possible risk is the failure of joints resulting in the camera falling and injuring the client, however, given the durability of the Posi-lock joints combined with the fact that the gooseneck does not fail in a manner fast enough to cause harm, this possible risk factor is negligible.

Technical Instructions:

To attach the wheelchair camera mount to the user's wheelchair, the device needs to be placed where the clamp can be attached to the frame of the wheelchair. There is a rotating joint at the bottom that is used to store the device at the side of the wheelchair. This will allow the user to have easy access to the product without having to get up from their wheelchair, the user only needs to unscrew the joint for it to be moved. Moving it in the clockwise direction brings it out of storage and moving it in the counterclockwise direction puts it into storage. Once the product is in a useable position the user can either use the device as a mount for her phone or a mount for her camera. To use the phone mount, the user will not have to do anything, aside from keeping the gooseneck section tucked in. To put the phone in the phone holder all that is needed is to unscrew the phone mount and to put on the phone. To use the camera mount function the second rotating joint needs to be unscrewed and turned in the clockwise direction. Now the user adjusts the gooseneck to the desired position and finally attaches the camera onto the camera mount. To store the device when it is no longer in use the user can unscrew the rotating joints and put the device in a stored position and screw the rotating joints up.

MakerRepo:

https://makerepo.com/radhikatakwale/gng2101-b01d-wheelchair-camera-mount

Conclusion

To conclude it took many hours from all group members to complete the product and none of this would have been possible without following the feasibility plan we made at the beginning of the semester, with some changes to fit outside circumstances. The product itself went through many iterations with more to come before we hand it off to the client. Economically we are capable of selling this device at a larger scale but it will take sacrifices from all involved for this business venture to succeed, although any successful small business owner would agree with that. The product is easy to use and well made but if there are any problems with the product, it can be fixed by one of our group members.

Recommendations

There are several aspects of the project that can be improved. The first is the connection between the two Posi-lock joints. Currently, it is plain steel with several screws and bolts sticking out, and while the part itself is solid and works perfectly, more could be done to make it presentable. The most basic task would be to countersink the boreholes the screws are currently running through, to prevent them from rubbing against the user's arm. The next step would be to wrap the arm in black shrink wrap to better match the color scheme of the rest of the product, as well as ensuring the rough edges of the screws are covered up.

Another aspect is the phone mount. The clamp our current phone mount uses to attach to the arm is on the large side and required several pieces of rubber to keep in place. Additionally, due to the way the screws controlling the tightness of the mount are set up, it is difficult to impossible to add levers to make using them easier. Finding a new camera mount, or even designing our own camera mount, is an excellent way to continue this project.