Switch-Operated Rotating Phone Stand
DESIGN RATIONALE

MACALESTER

Overview and Purpose of Our Project

The design problem we set out to solve was enabling photographers to capture steady images and videos without manually holding their phone. Many photographers struggle to hold their camera steady, particularly when taking panoramas or recording videos. Our solution was to create a fully functional rotation phone stand controllable with assistive switches and designed with accessibility, user convenience, and cost in mind. We followed a user-centered design process to ensure the final product would meet the real-world needs of photographers who would benefit from hands-free operation. In this document, we will reflect on each stage of the design process and how our decisions were grounded in design research, principles, and user feedback.

Throughout this project, we were intentional about rejecting outdated models of disability like charity and medical, which frame disabled users as passive recipients of aid or as problems to be fixed. We embraced it more from an inclusive framework, particularly looking at the social and identity models of disability. This model's main point is that disability arises from environmental mismatches and states that the environment is not well suited for the user, and this creates disability. We tried to create something like this that would expand the scope of the environment when it comes to photography, as we are not just making it easier to photograph; there is also a component of inclusivity that comes with an automatic phone stand that others don't have.

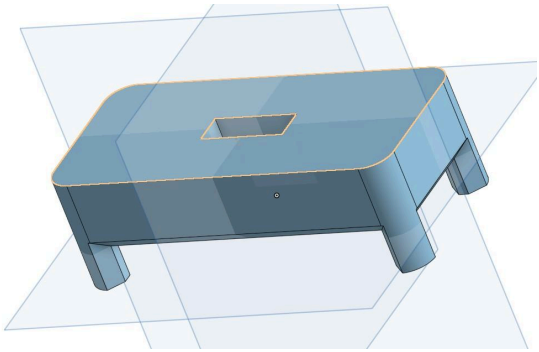
Another aspect was Wobbrock's ability-based design, Ladner's emphasis on user empowerment, and Ko's critique of design for the "average user." We prioritized adaptability and personalization in our rationing phone stand. Rather than treat users as test subjects, we involved their input early, particularly during conversations with photographers like Jasper, who directly shared our design priorities for the phone, and when it comes to flexible sizing and mounting angles. We tried to make this a space of co-creation where we and the user worked together, giving the user visual and functional input into the device's outcome. This was a big point we tried to incorporate throughout our testing.

Design Process

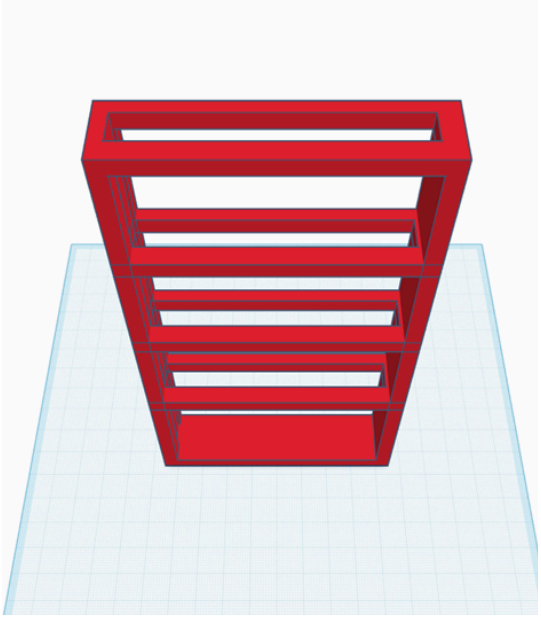
Stage 1: Initial Design Exploration

Users will need access to a 3D printer to create this phone stand. The printers we used were the Prusa MK4 and the Prusa MK3S. The user will also need an Arduino board; we used the Sparkfun Redboard programmed with Arduino because of its USB-C compatibility, which is almost universally compatible with any modern computer. You will need to download the Arduino IDE to program this board. You will also need 3.5mm jacks and copper wire for soldering. We designed this product to connect to 2 interactive switches from MakersMakingChange. The parts of this project that we designed or adapted are the Servo base

and the Phone stand. We designed the Servo base – the component which holds the servo and hides the Arduino board + all of the wiring – using an online software called OnShape. This software allowed us to 3D model using exact measurements, which was how we held the Servo tightly. Here are images of the 3D model for the base:

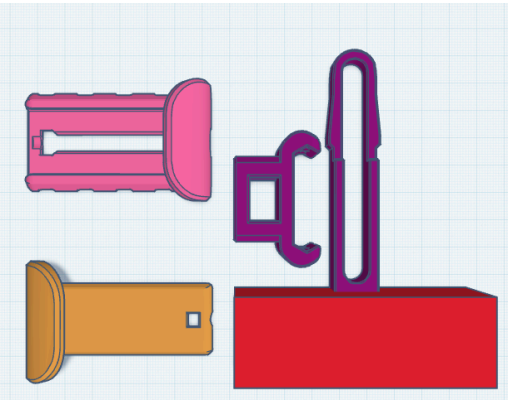
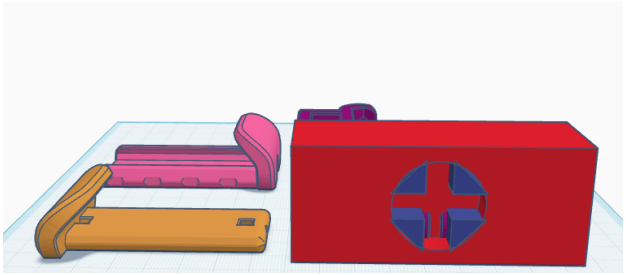


Next, we found an adjustable phone mounting system online on a website called Cults (link to design). We adapted parts of this model to create a phone stand that could securely attach to the head of our servo motor. The advantage of using this existing design was that it already supported adjustability for different phone sizes and angles. In construct, our original concept, a fixed cage-style holder sized for an iPhone 16 Pro Plus, lacked flexibility and failed to accommodate other devices, as shown here:



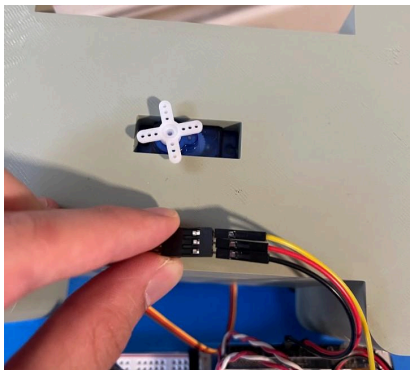
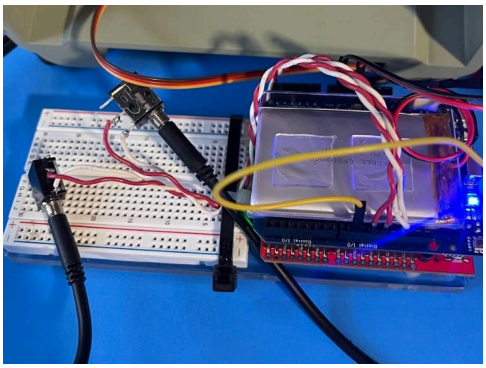
The inspiration came from a FaceTime call with a photographer named Jasper, who, when showing around, mentioned the lack of flexibility with phone sizing. Also, I want to show

him the original concept and the ability to be vertical or horizontal. Here is what the new version, based on the Cult phone mounting system parts, looks like from a top and side view:

Stage 2: Assemble materials

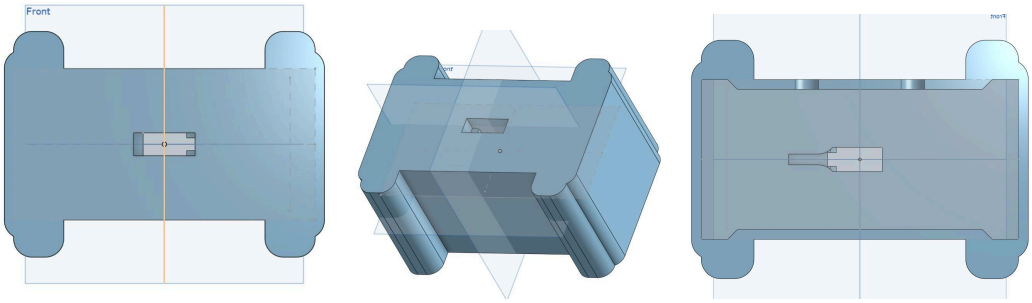
Once all parts of this phone stand have been gathered/printed (using our 3D print guide), the user needs to connect the two switches and the Servo motor to the Arduino board. The Servo's ground should be connected to the Arduino, and the 5V power should be connected. Then, the user should use pin 9 to connect the Servo's signal to the Arduino, allowing the Servo to receive inputs from our program. Once this is done, the user needs to connect the switches. To do this, the user will solder each switch to one end of a cable, the other ends will go into the same ground pin (not the same as the servo, but both 3.5mm connections should plug into the same ground as each other), and then each to its digital input pin. We used pins 11 and 12 for the switches, which you can see in our program. A link to the code we used to run this project is here. The code is quite simple; it takes input (HIGH or LOW) from the switches and then moves the Servo accordingly. Once the wiring is done, it should look something like this:

Stage 3: Iteration

Our group had to make changes based on our intuition because we could not complete our user testing before any iterations. One of our changes was to update the Servo base so that it

was tall enough to cover the Arduino board completely and accommodate the wiring for the switches. This was done again using OnShape and by making some precise measurements. Here is what our final design looked like for the Servo base:



Our rationale behind this change was so that users can hide the messy wiring of the phone stand and protect the Arduino board from harm. Another adjustment we made was to the phone stand. This was previously mentioned, how we moved from a cage concept to a stand taht could adjust sizing and go horizontal and vertical. We had to make a minor tweak to the sizing of the servo, as the original attempt was too big and loose. Here is a photo of the adaptation we made so that the stand could fit on top of the Servo head:

It is also important to note that our team had to modify our choice in Servo due to mechanical failure. Our initial Servo had 360-degree motion and was controlled using magnitude in a direction. This Servo broke for an unknown reason, so we had to purchase a different Servo with only 180 degrees of freedom, which used degrees as motion. While this is not technically an iteration, it is a design choice we had to make to have a functioning product by the end of our deadline.

Conclusion and Future Improvements

Reflecting on our process, several key decisions stand out, like staying flexible, responding to and incorporating user feedback, and constantly adjusting our design choices. One surprise was the servo

failure, which forced a last-minute change and highlighted the importance of designing for replacability because we designed for a generic servo shield, which allowed for easy replacement. While exploring various designs, we ultimately chose the options that best balance user comfort, affordability, and universal design. Our final prototype is a sprint in these categories and is easy to print and iterate upon.

We also tested the final product with a user named David, a photographer, who had never seen the device before. After trying it out, he said it was intuitive and worked as he thought it would. One future direction based on his feedback was to allow the user to go left or control the rotation speed of the servo. But overall, he was pleased with the button and the ability to turn your phone vertically or horizontally, which was intuitive and easy for him. Overall, the final user test validated that our phone stand was complete.

Even though the current version has limitations in terms of constant speed, this can be addressed in future iterations. We tried our best to build from an inclusive framework. That being said, one gap is in our process; we did not have access to users with physical disabilities. Thus, it is hard to know if we could truly accomplish the goal of an inclusive framework, outside of the fact that the user photograph we did say our design would work for someone with disability. If given more time, we would have tested on people with disabliy who are photographers as well and tried to design a speed toggle. Overall, this project we created made it easier for us to understand our user group and develop something that could be super practical for the average iPhone photographer.