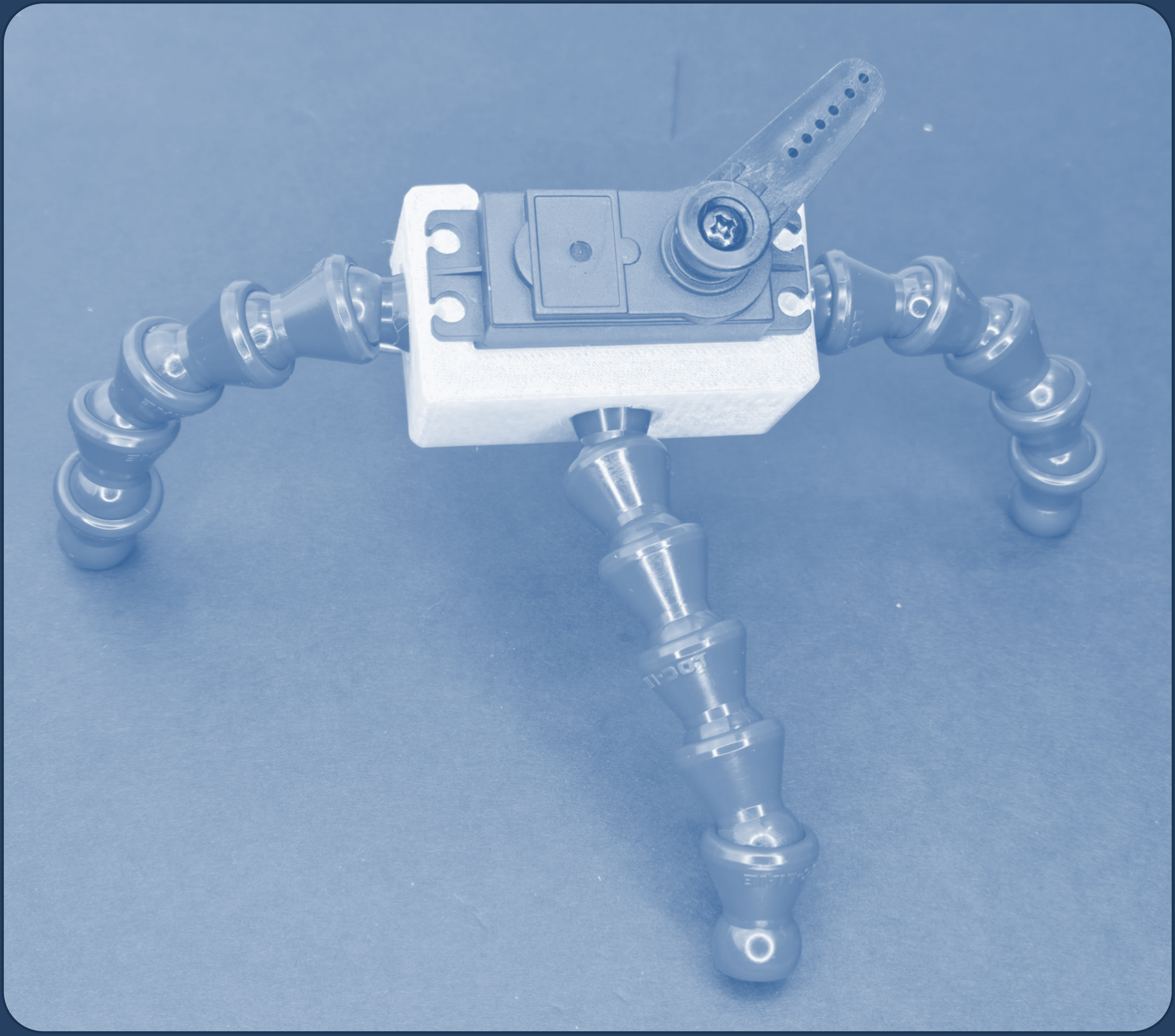
SMARTSERVO

FLEXIBLE MOUNTING: REACH EXTENDER KIT



SMARTSERVO PROJECT

FLEXIBLE MOUNTING: REACH EXTENDER KIT

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Commercial Use & Smart Servo Requirement

For commercial use, bulk educational licensing, or use outside of traditional educational settings, please contact Wagner Labs LLC.

Hardware Requirement: This guide requires **Smart Servo devices** to complete the projects and activities described. Smart Servos are available through the Smart Servo Store and authorized distributors.

About the Smart Servo Project

The Smart Servo Project empowers inclusive innovation by providing accessible tools for creating assistive technologies and engaging STEM education. Our mission is to bridge technology and compassion through community-driven maker education.

Support our mission by purchasing Smart Servos and sharing our resources with your educational community.

Contact Information:
Judson Wagner | Wagner Labs LLC
Email: **Judson@WagnerLabs.net**
Website: **WagnerLabs.net/SmartServo**
Smart Servo Store: **WagnerLabs..Store**

Client: Marcus, Age 14

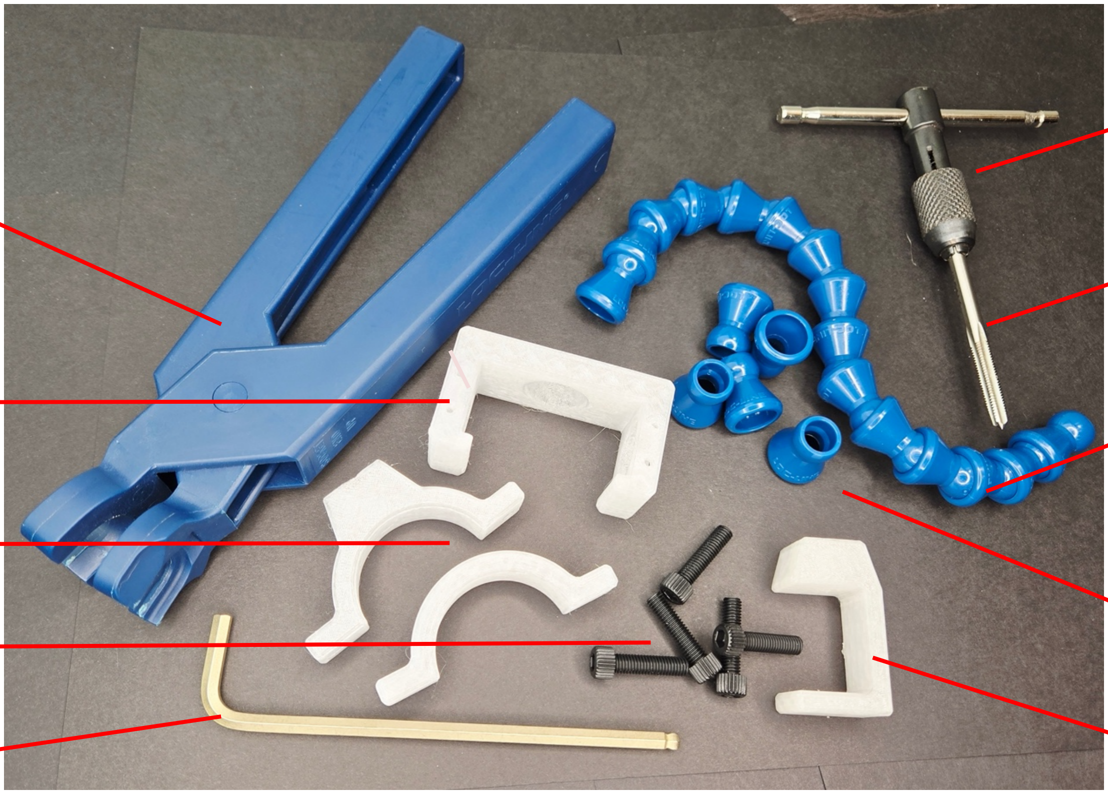
About Me: I'm an 8th grader who loves participating in class discussions and debates. I have muscular dystrophy, which affects my arm strength, making it difficult for me to raise my hand high enough for my teacher to see from across the room.

My Challenge: In my larger classes, especially social studies where we have really engaging discussions, I often know the answer but can't get my teacher's attention. By the time I slowly raise my arm partway up, someone else has already been called on. It's frustrating because I'm an active learner who wants to participate.

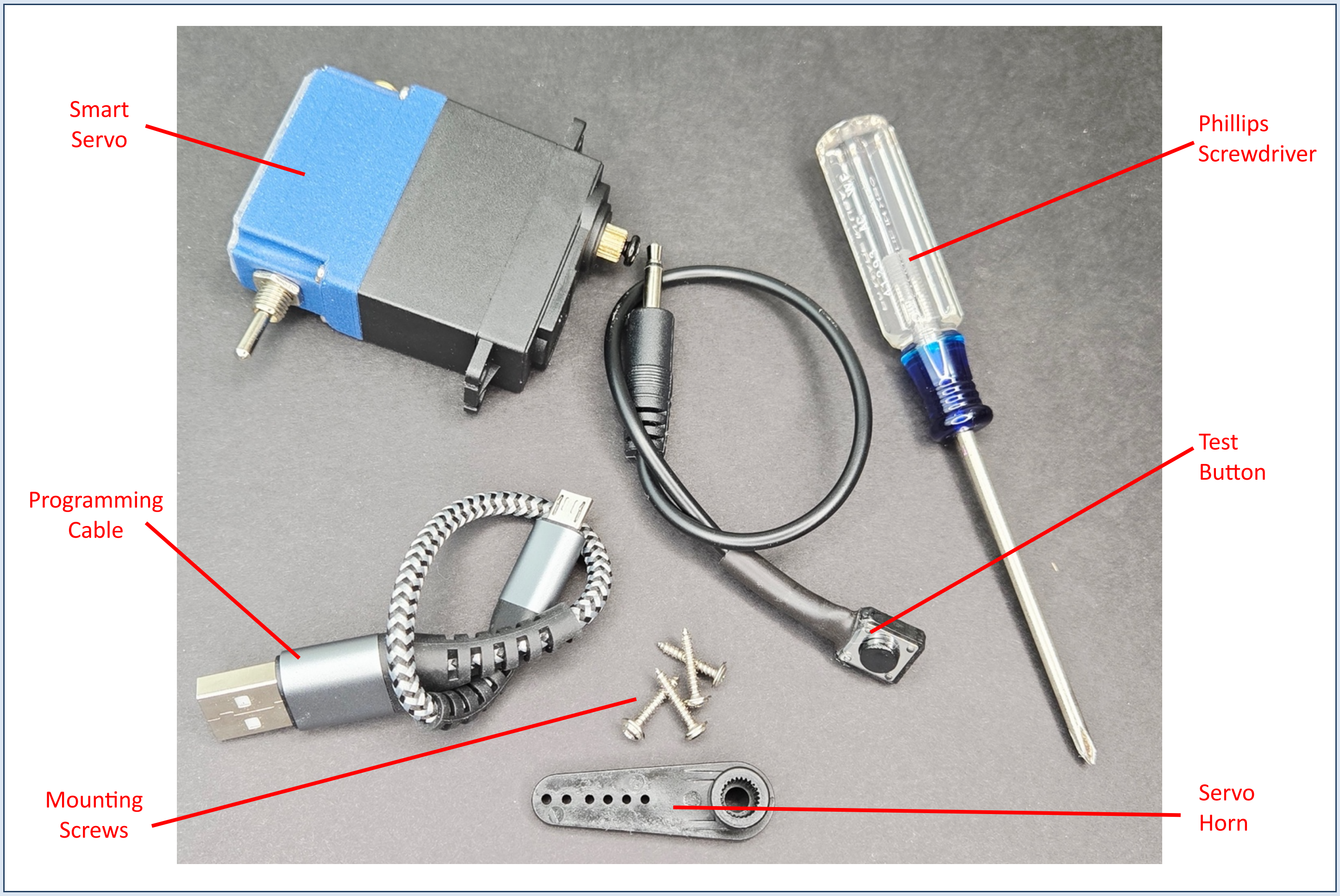
Technical Need: A flexible, wheelchair-mountable hand-raising device that can extend and position at the optimal height and angle for classroom visibility, activated by an accessible button.

Let's now investigate our kit and see if we can get started on something that can assist Marcus.

STEP 1: Lay out and identify all the components that are new in this kit.

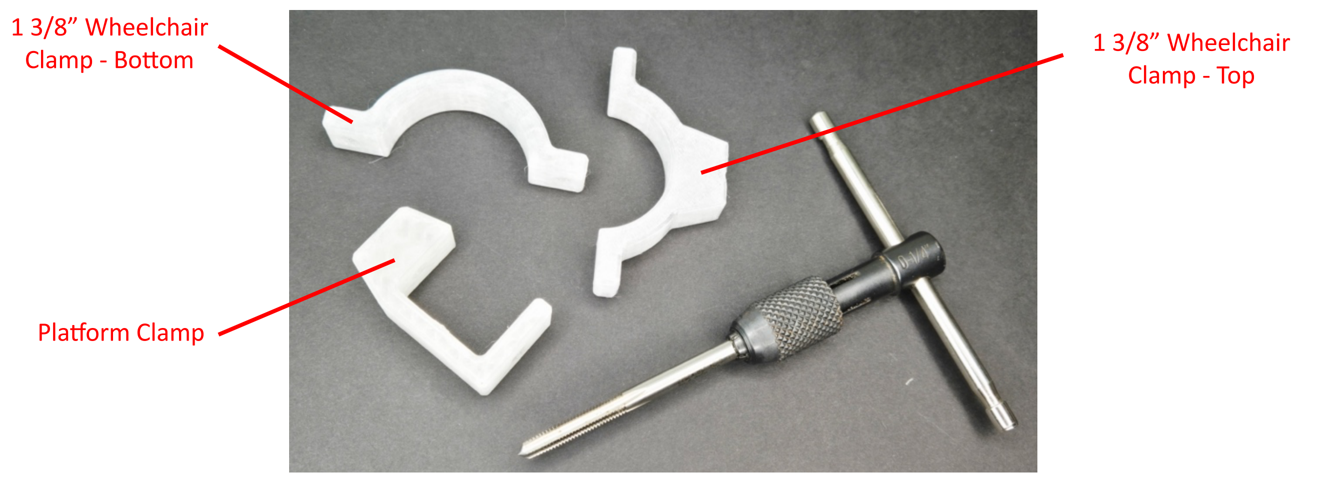


STEP 2: Make sure you have these items from your previous kit.

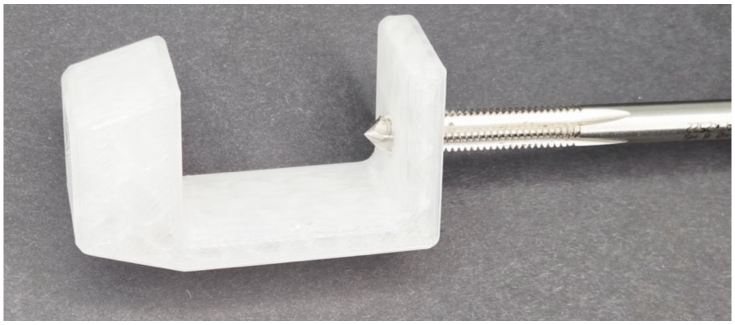


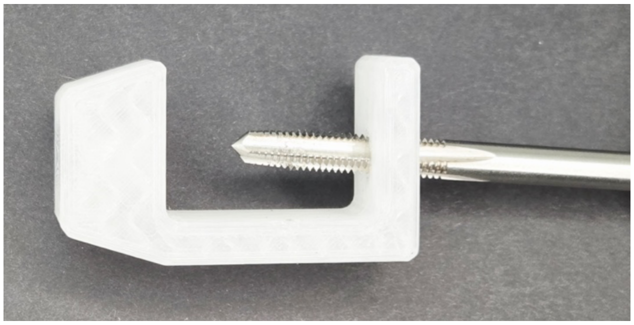
STEP 3: Connect your M5 Tap to the Tap Handle. Be sure to screw it down tightly using the collet.

STEP 4: We need to tap threads into some of the 3D printed parts. Pull together the parts shown below.

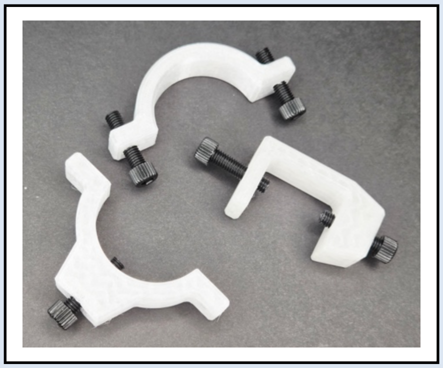


STEP 5: To tap, make sure the tap is completely perpendicular (or the best you can) to the 4.3mm holes in these parts. You want to turn the tap handle slowly applying steady inward pressure as you turn. The goal it to carve threads into the material so we don't want to "drill" out the hole. Also, make sure all of the tap passes through the hole and brush or blow away debris (This is a compostable material but just like wood shavings you should avoid inhaling in a well-ventilated space). Back the tap out of the hole in the reverse direction without pulling to ensure a complete cut.





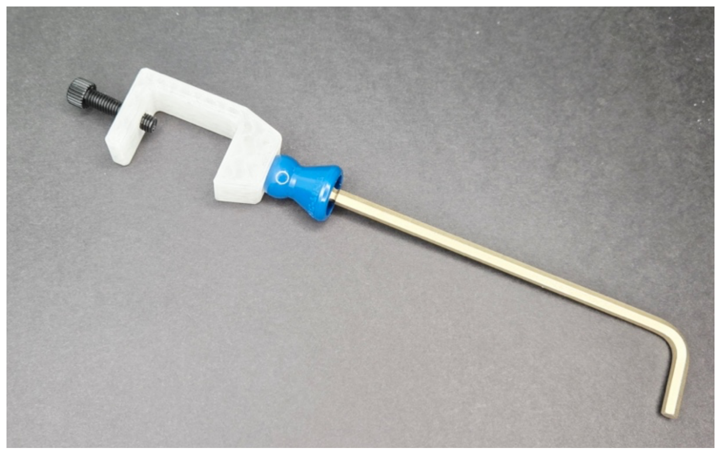
STEP 6: Test the quality of your tapping by inserting the M5 screws by hand. They should go in smoothly and you shouldn't be able to pull them out. If the screws are tight or difficult to turn by hand, consider re-tapping.



This is a temporary test so remove the screws when satisfied with the tapping.

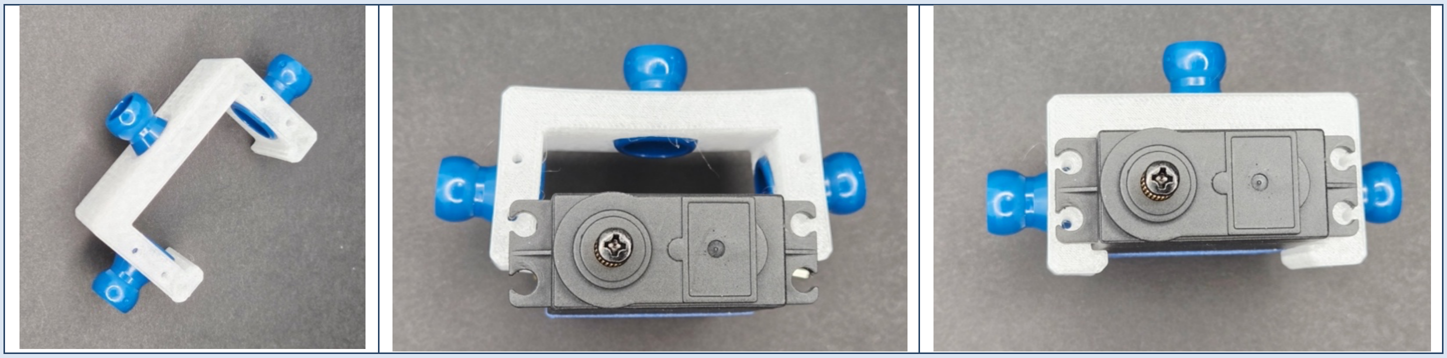
STEP 7: If your ¼” Loc-Line is fully connected as one continuous part, use the Loc-Line tool to separate some of the pieces. Place a M5 screw into one of these pieces as shown.

STEP 8: Put the exposed end of the M5 screw into the platform clamp (or the Wheelchair Clamp - Top) and use the 4mm Allen Key to tighten it down tight.

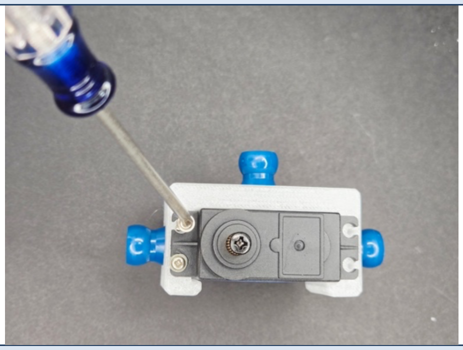


STEP 9: Connect Loc-Line pieces to both the Platform Clamp and the Wheelchair Clamp – Top. Set these assemblies aside.

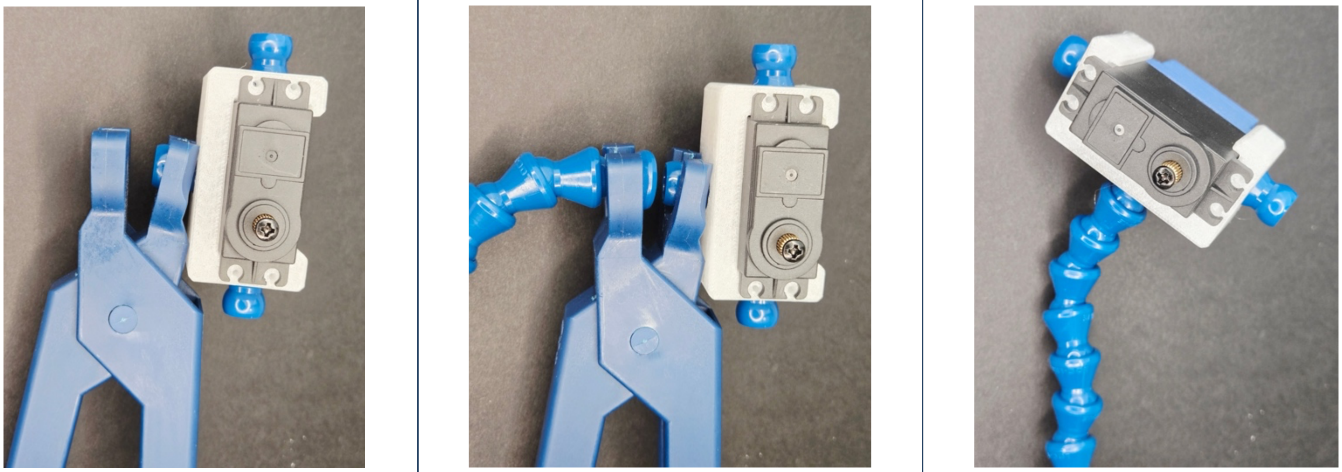
STEP 10: Get your Smart Servo, your Smart Servo Loc-Line Bracket, and up to three individual Loc-Line pieces. Insert at least one Loc-Line piece into the large holes in the bracket so that the smaller end sticks out and away. Now bend the bracket so that it fits over the Smart Servo as shown. The bracket as plenty of flex but it does take some effort. Pull the bracket around the Smart Servo so that it fits snug, and the Loc-Line pieces are held tight against the Smart Servo.



STEP 11: The bracket should be secure enough for most applications, but mounting screws can be added for additional security.

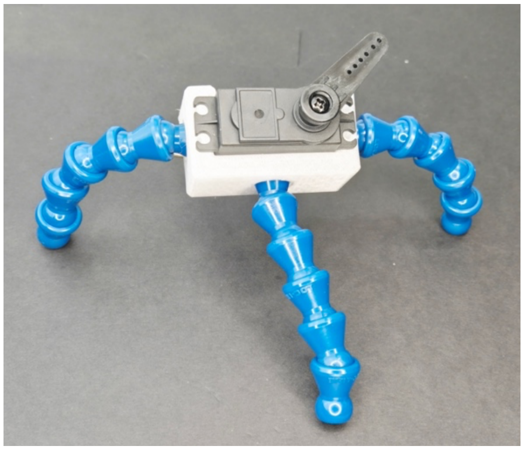


STEP 12: Use your Loc-Line tool to connect additional Loc-Line pieces to the bracket.

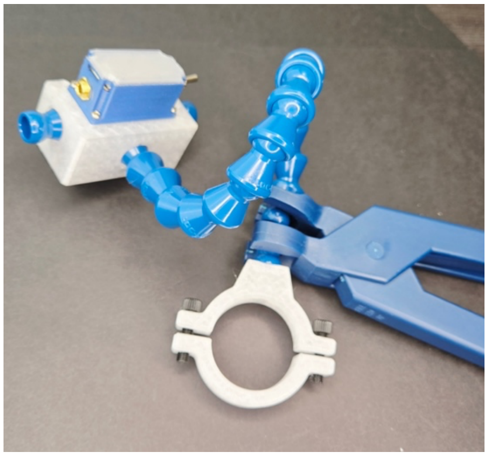


STEP 13: At this point, you can use the Loc-Line system to simply raise the Smart Servo off of a surface.





STEP 14: Finally, connect the other end of the Loc-Line tubing using the Loc-Line tool to one of the clamps set aside in Step 9.



CONGRATULATIONS!

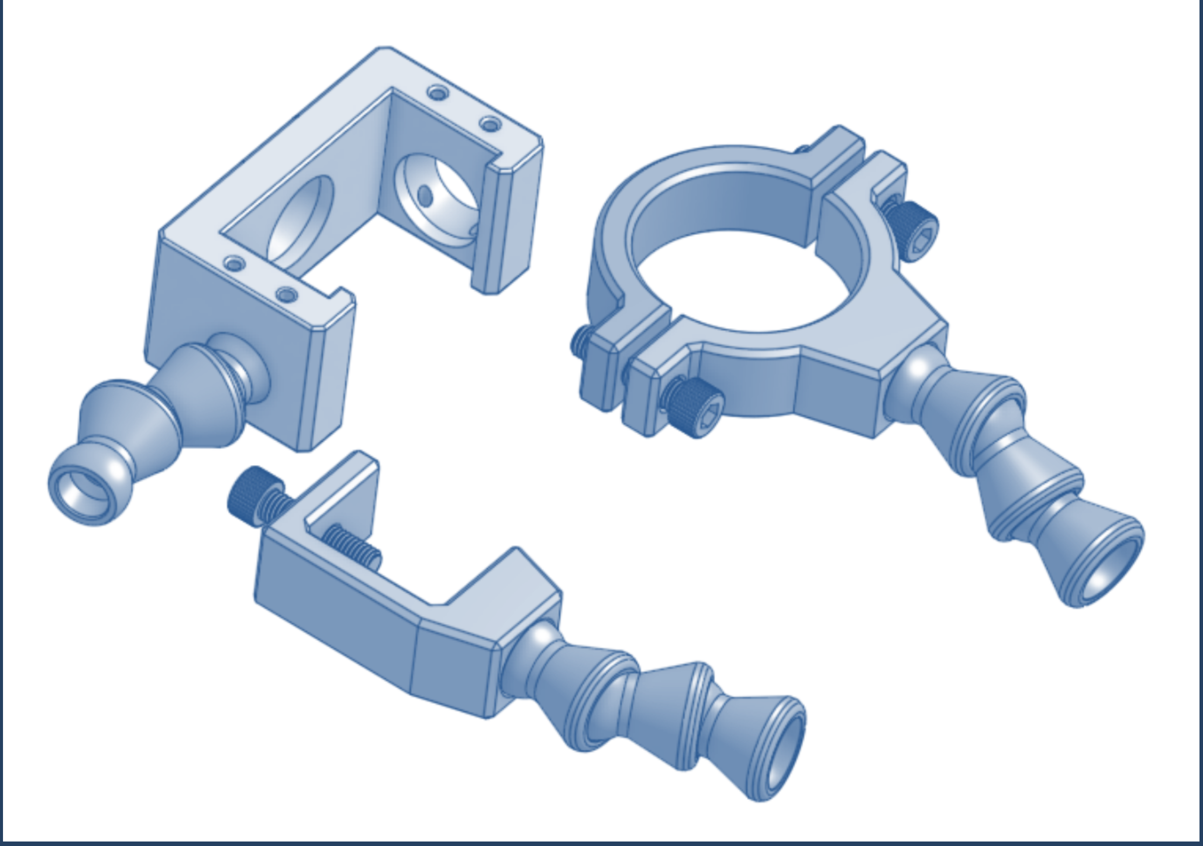
You just constructed a flexible mounting system for the Smart Servo. Next, we'll want to consider what needs to be done next to better assist Marcus. Read his profile again and see if he would appreciate something like this reach extender. If so, reflect on what follow up questions you would ask him and what else he would need to use it.

REMINDER ABOUT CODING SNIPS

If you want to return your code to the original "factory setting", just copy and paste from here: tinyurl.com/SmartServoSnips

3D PRINTING FILES

If you're able to 3D Print, download the 3D parts used in this project here:
tinyurl.com/SS-STL-REACH



THE BIGGER PICTURE

UNDERSTANDING DEGREES OF FREEDOM IN YOUR FLEXIBLE MOUNT

Understanding Degrees of Freedom

Your LocLine mount gives you something roboticists call "degrees of freedom" - the number of independent ways something can move in space. Each ball-and-socket joint in the LocLine adds rotational freedom, allowing you to position the hand-raiser at almost any angle needed. In robotics and engineering, understanding degrees of freedom is crucial for designing systems that need to reach specific positions or orientations.

A rigid rod mounted at one point has limited usefulness - it can only swing in an arc around its base. Add one ball joint and you suddenly gain multiple rotational degrees of freedom, letting you tilt and angle in ways that were impossible before. String several LocLine segments together, and you create what engineers call a "serial manipulator" with many degrees of freedom. This is the same fundamental principle behind robot arms in factories, surgical robots in operating rooms, and even your own arm - your shoulder, elbow, and wrist work together to give you seven degrees of freedom for positioning your hand anywhere within reach.

The Trade-off Between Flexibility and Precision

More degrees of freedom sounds like it's always better, but there's a hidden cost that every engineer must consider: the more flexible something is, the harder it becomes to control precisely and the less stable it can be. Your LocLine mount is infinitely adjustable, but it must be manually positioned and then locked in place by friction between the ball joints. Industrial robots with six or seven axes of movement require complex computer control, sophisticated sensors, and powerful motors to know exactly where they're positioned at every moment and hold that position under load.

Engineers constantly balance flexibility against stability, adjustability against repeatability. Camera tripods sacrifice quick adjustability for rock-solid stability - photographers need their camera to stay exactly where positioned. Adjustable standing desks trade some stability for height flexibility, accepting a bit of wobble as the price of adaptability. Medical microscopes use precisely engineered counterweights and friction joints to give surgeons both positioning freedom and the unwavering stability needed for delicate work.

Finding the Right Balance for the Task

Your LocLine solution is actually ideal for many assistive technology applications precisely because it finds a sweet spot in this engineering trade-off. Marcus doesn't need his hand-raiser to reposition itself hundreds of times per day with computer-controlled precision. He needs something that can be adjusted to his specific classroom setup, stay reliably in position throughout the school day, and be readjusted when circumstances change - perhaps when he moves to a different classroom or his wheelchair setup changes.

This human-centered approach to degrees of freedom appears throughout good engineering design. Desk lamps use friction joints for occasional repositioning rather than motors. Shower heads mount on sliding rails with adjustable angles. Microphone boom arms in recording studios use counterweighted joints that stay positioned without power. Each solution matches the degrees of freedom - and the control mechanism - to the actual human need rather than over-engineering with unnecessary complexity or under-engineering with insufficient adjustability.