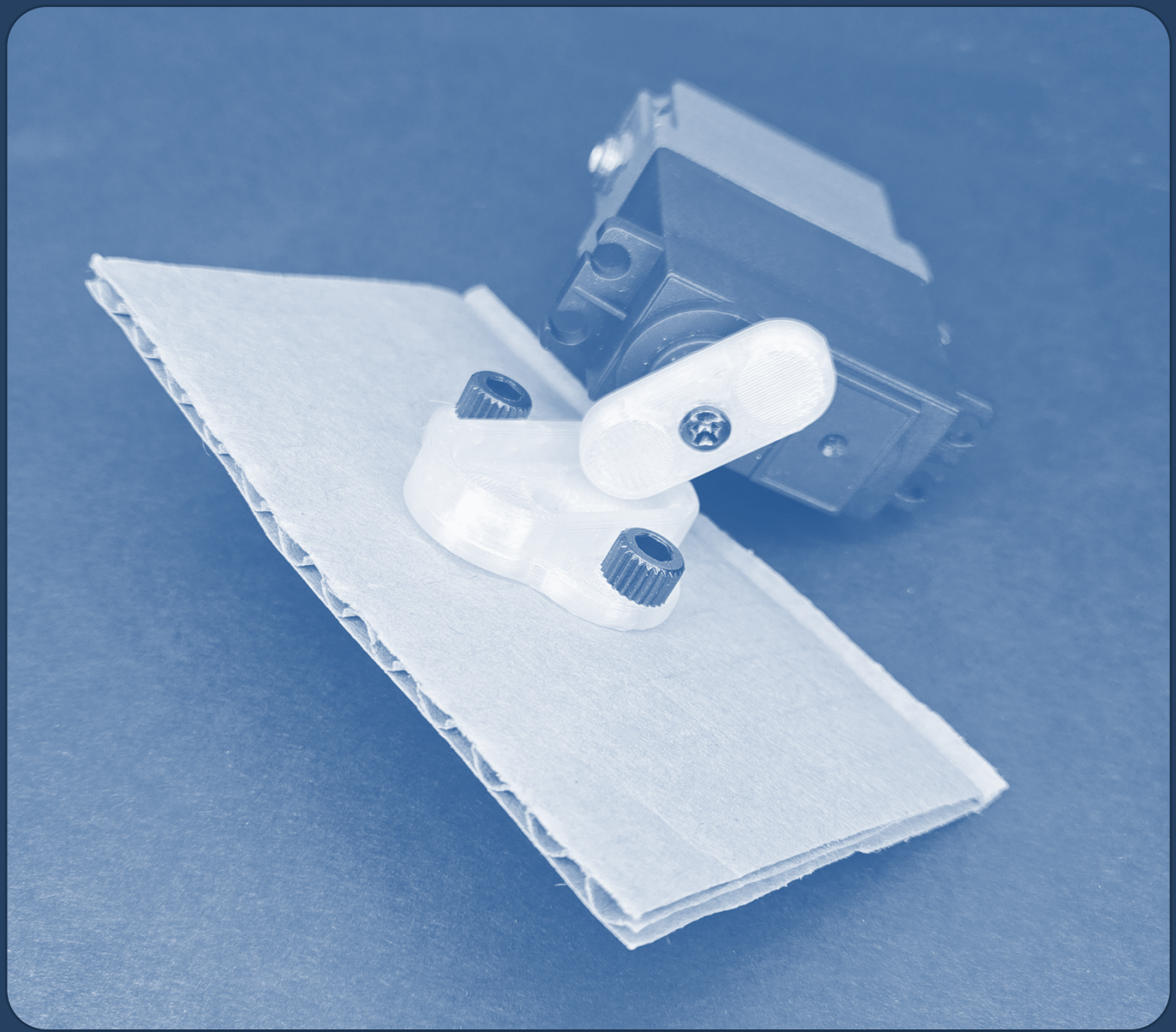
SMARTSERVO

LOW-FI PROTOTYPING: QUICK EXCHANGE KIT



SMARTSERVO PROJECT

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Version 1.0 | Published: June 17,2025 | Author: Judson Wagner, Wagner Labs LLC

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.

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Website: **WagnerLabs.net/SmartServo**
Smart Servo Store: **WagnerLabs..Store**

Client: Sofia Gonzalez, Age 16

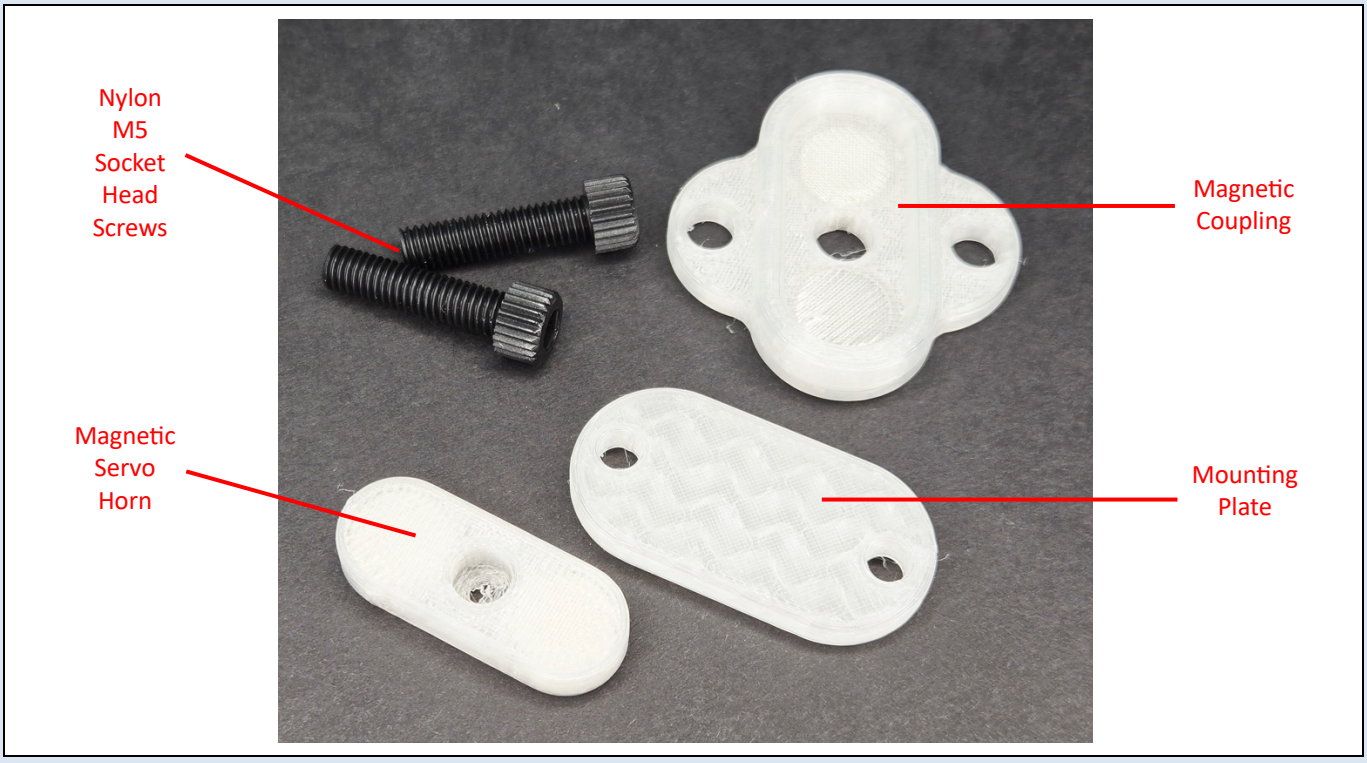
About Me: I'm a high school student who loves science and wants to study biomedical engineering. I have cerebral palsy that primarily affects my fine motor control and hand coordination, though I have good cognitive abilities and problem-solving skills.

My Challenge: In my science lab workspace, I'm constantly balancing two competing needs: I need tools and equipment positioned exactly where I can reach them accessibly when I'm using them, but I also need them completely out of my way when I'm not. Because of my limited fine motor control, I can't easily move equipment around or reposition things on the fly like my classmates can. Traditional fixed mounting puts things in one spot - either accessible or out of the way, but never both. Adjustable mounting with screws and clamps requires the precise finger control I don't have. I need a system that lets me optimize my lab workspace, but I don't know yet what configuration will work best - I need to try different options quickly to find out.

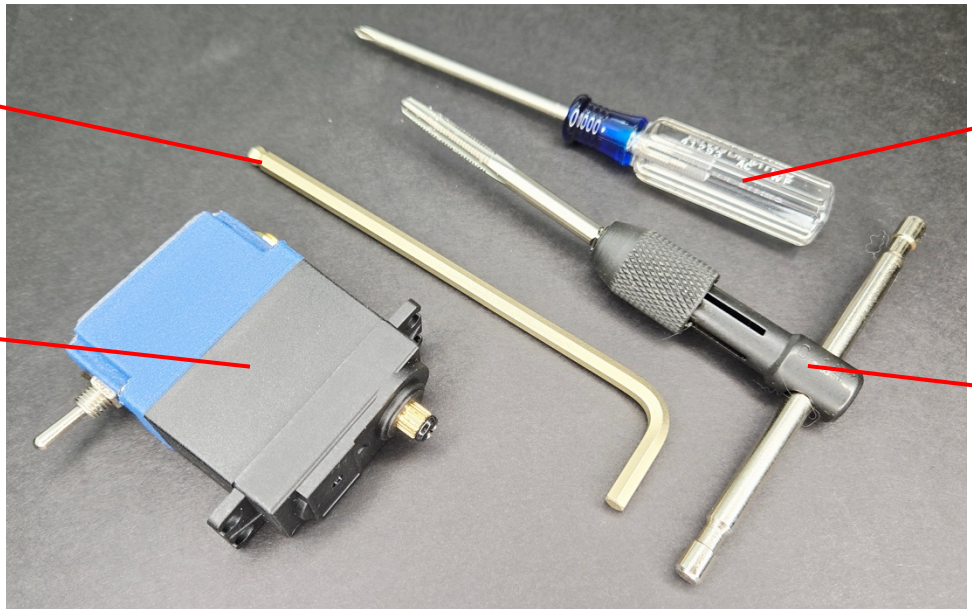
Technical Need: A collaborative prototyping approach using quick-release mounting and servo actuation to rapidly explore multiple workspace configurations - testing various positions, heights, and arrangements for equipment storage and access. Rather than designing one "final" solution, I need a diverse set of low-fidelity options that I can evaluate in my actual lab environment. Once an optimal configuration emerges from testing, the system can be refined into a permanent solution.

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

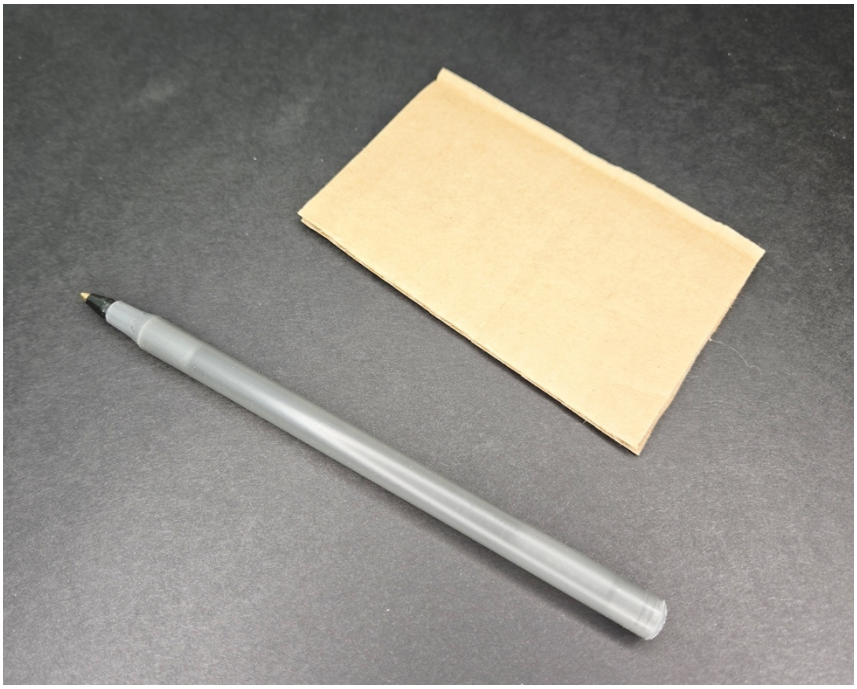
STEP 1: Lay out all the components that are new in this kit.



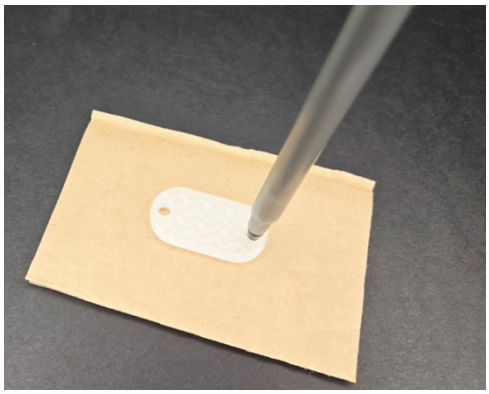
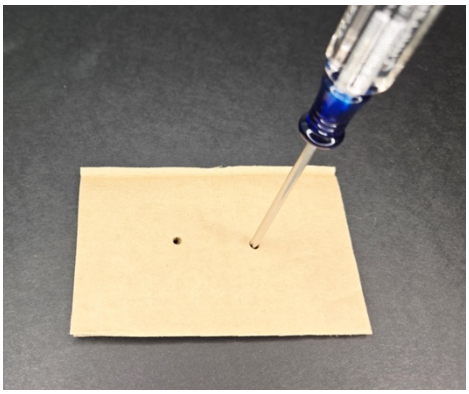
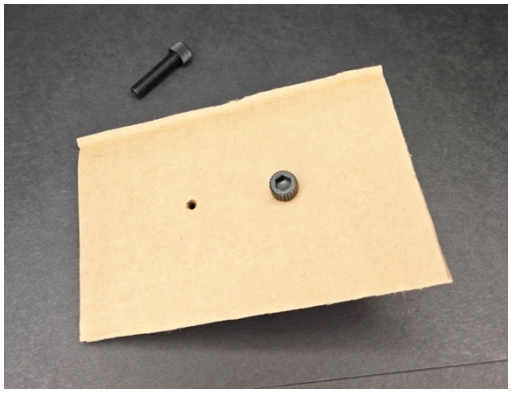
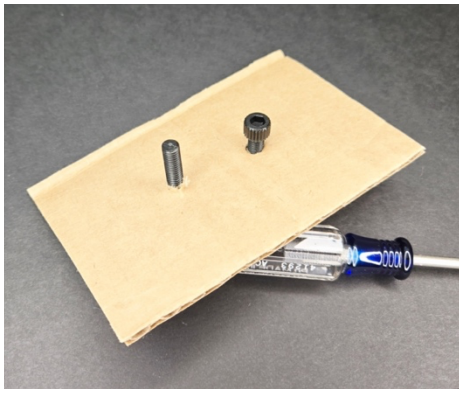
STEP 2: Make sure you have these items from your previous kits.



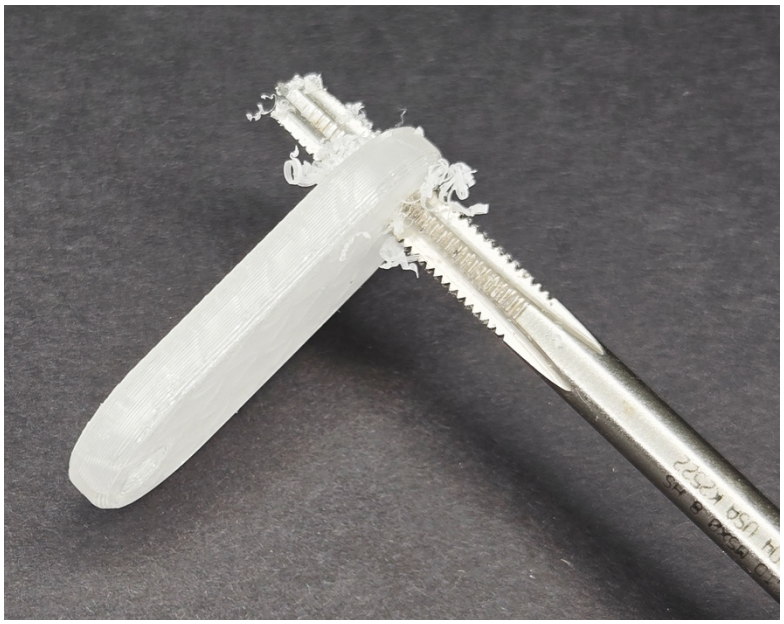
STEP 3: In addition, find some Cardboard and something that can write on the Cardboard such as a Pen.



STEP 4: Place the Mounting Plate on the Cardboard and use it as a stencil to mark the two holes. Use the Philips Screwdriver to poke holes at these marked locations. We want the holes large enough to be able to push the M5 Socket Head Screws through.

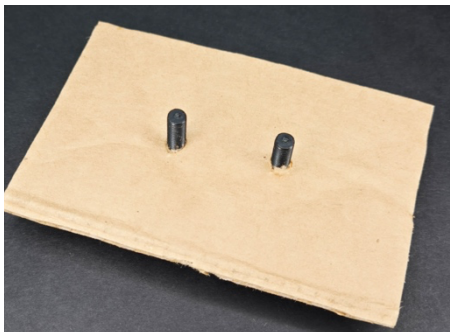





STEP 5: Use the Tap to carve out threads in the two holes on the Mounting Plate.

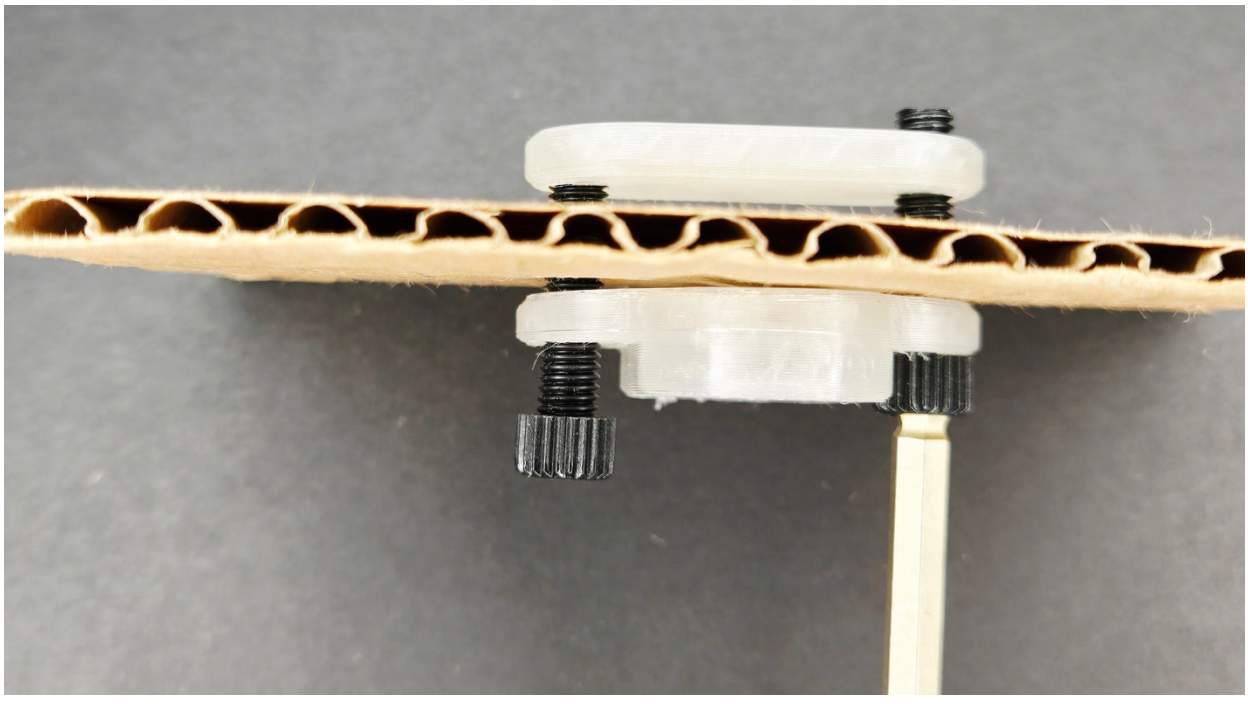


STEP 6: Push the Socket Head Screws through the holes in the Magnetic Coupling from the direction shown below. Then push the screws through the holes you made in the Cardboard so that the Coupling is flat against the Cardboard.



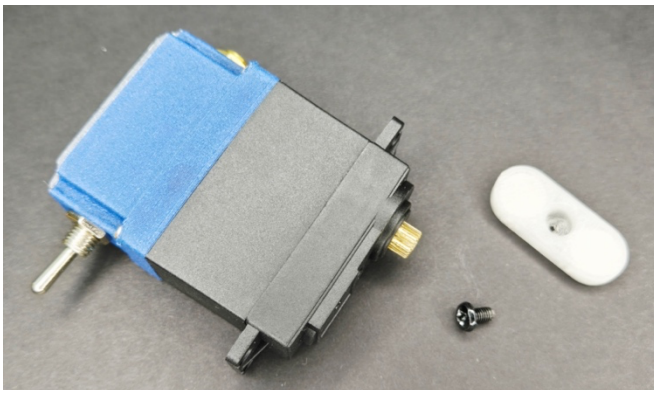
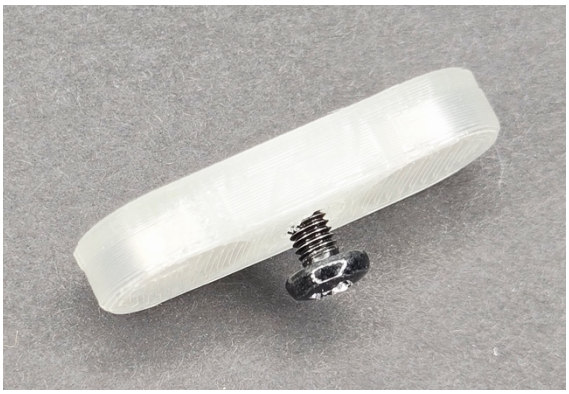


STEP 7: Place the Mounting Plate on the other side of the Cardboard and use the Allen Key to secure the Coupling to the Cardboard.

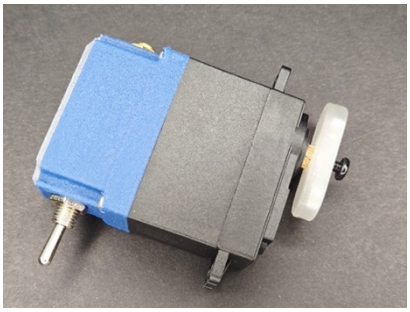
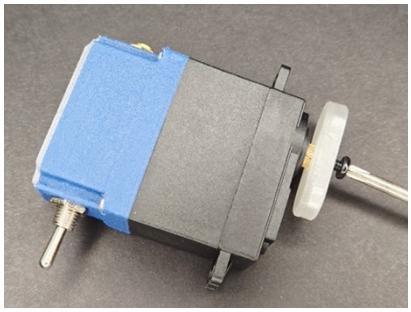
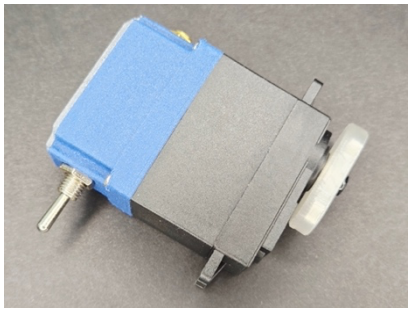


Consider that this magnetic Coupling can be added to any piece of cardboard.

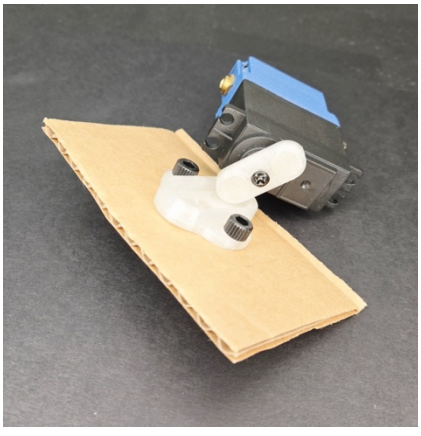
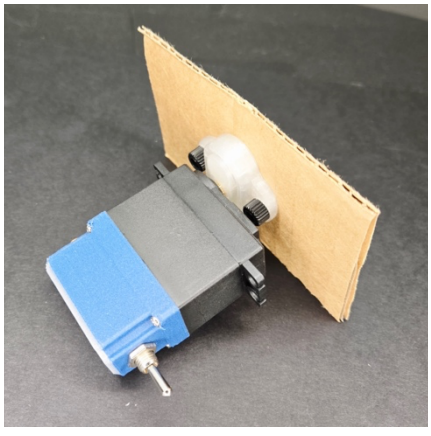
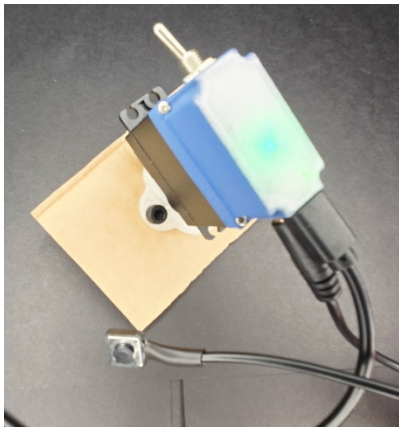
STEP 8: Remove the Spline Screw from the Smart Servo and insert it into the smaller hole of the Magnetic Servo Horn. (The larger hole on the other side of the Magnetic Servo Horn has the spline teeth needed to reattach to the Servo Spline.)

STEP 9: Fit the Magnetic Servo Horn onto the Smart Servo Spline and screw in the Spline Screw. Make sure to check that the Spline Screw pulls the entire Magnetic Horn onto the Spline.

STEP 10: Finally, check that the Cardboard Magnetic Coupling can quickly connect and disconnect from the Magnetic Horn. Then check to see how the coupling works with the Smart Servo powered up and operated with the Testing Button.

CONGRATULATIONS!

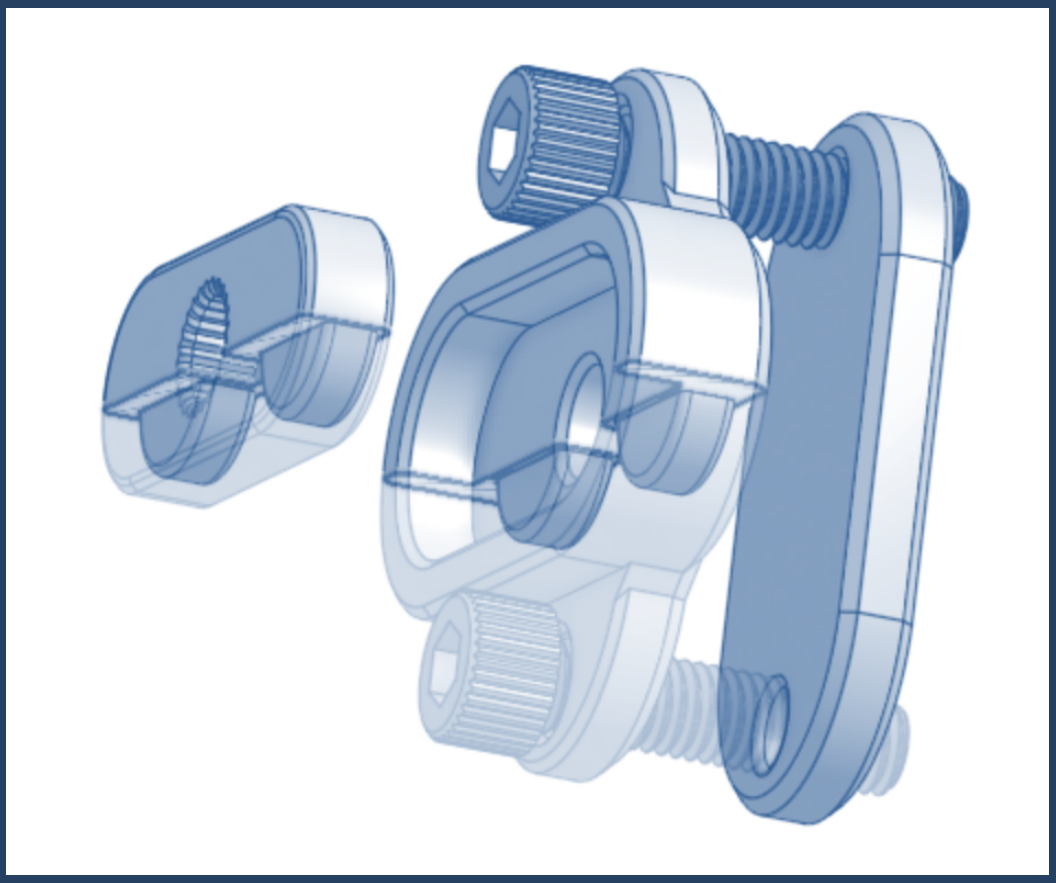
You just created a quick-release coupling system for rapid prototyping. Next, we'll want to consider what needs to be done next to better assist Sofia. Read her profile again and think about her lab workspace challenges. What follow-up questions would you ask her to understand which configurations to test first? Remember, the goal isn't to build one perfect solution yet—it's to explore many possibilities together.

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-PROTO



THE BIGGER PICTURE

UNDERSTANDING CO-DESIGN THROUGH RAPID PROTOTYPING

The Challenge of Designing for Unknown Solutions

Sofia faces a workspace optimization problem that can't be solved by simply asking "what do you need?" She knows her challenge - equipment must be accessible when needed but out of the way when not - but she doesn't know which specific configuration will actually work in her lab space. This is common in assistive technology: users can clearly articulate their problem but can't visualize solutions until they experience them physically. This is where co-design becomes essential - a collaborative process where users and engineers discover solutions together through rapid experimentation.

Your quick-release coupling system transforms this discovery process from theoretical to practical. Instead of drawing sketches or describing ideas in words, you can build quick cardboard prototypes, snap them onto the servo mount, and let Sofia physically test them in her actual workspace. Does this height work? Is this angle accessible? Does it interfere with other activities? These questions can't be answered through discussion - they require real-world testing with the actual user in their actual environment.

Why Low-Fidelity Prototyping Enables Discovery

Cardboard prototypes are perfect for this exploratory phase precisely because they're disposable and quick to modify. If you invested hours 3D printing a "perfect" solution, you'd be psychologically committed to making it work even if testing reveals problems. Cardboard costs pennies and takes minutes - you can throw away "failures" without hesitation and try something completely different.

This freedom to fail fast accelerates learning dramatically. Professional design firms like IDEO build dozens of rough prototypes specifically to explore the solution space widely before committing to any direction. Medical device companies test cardboard mockups with doctors before engineering expensive functional prototypes. Your quick-release coupling makes this even faster - snap on an idea, test it, pop it off, try the next one.

Divergent and Convergent Thinking in Engineering

This kit teaches a crucial design methodology: alternating between divergent thinking (generating many possible solutions) and convergent thinking (evaluating and selecting the best option). As the engineer, your role is divergent exploration - creating multiple prototypes representing different approaches. Should equipment swing in from the side? Drop down from above? Slide forward from behind? Each represents a valid hypothesis worth testing.

Sofia's role is convergent evaluation - experiencing each option and providing concrete feedback about what actually works in her real environment. "This height works but the angle doesn't." "This is perfect for reaching but blocks my view." Her domain expertise - understanding her body, her tasks, her space - is as valuable as your technical expertise. Neither of you can solve this alone; together, through iteration, you converge on solutions neither could have predicted.

The goal isn't producing a finished product this month - it's developing a methodology for discovering solutions through user collaboration. Once Sofia identifies a configuration that actually works through real-world testing, then you can refine it with better materials and permanent mounting. But that refinement only succeeds because the exploration phase prevented you from building the wrong thing well.