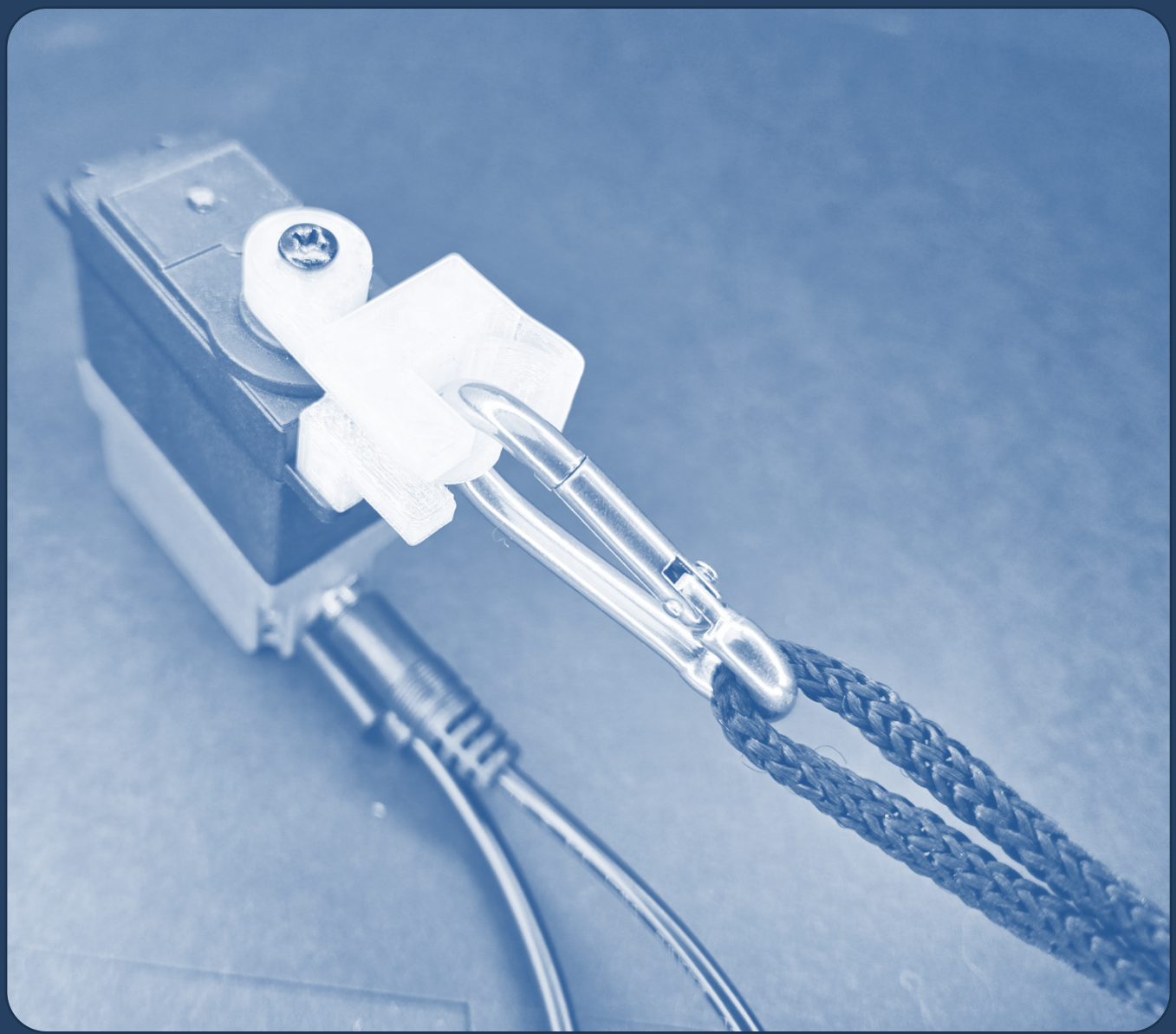
SMARTSERVO

SMART LOCKING:
SECURE & RELEASE KIT



SMARTSERVO PROJECT

SMART LOCKING: CLICK-LOCK KIT

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.

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

Client: Robert Kim, Age 45

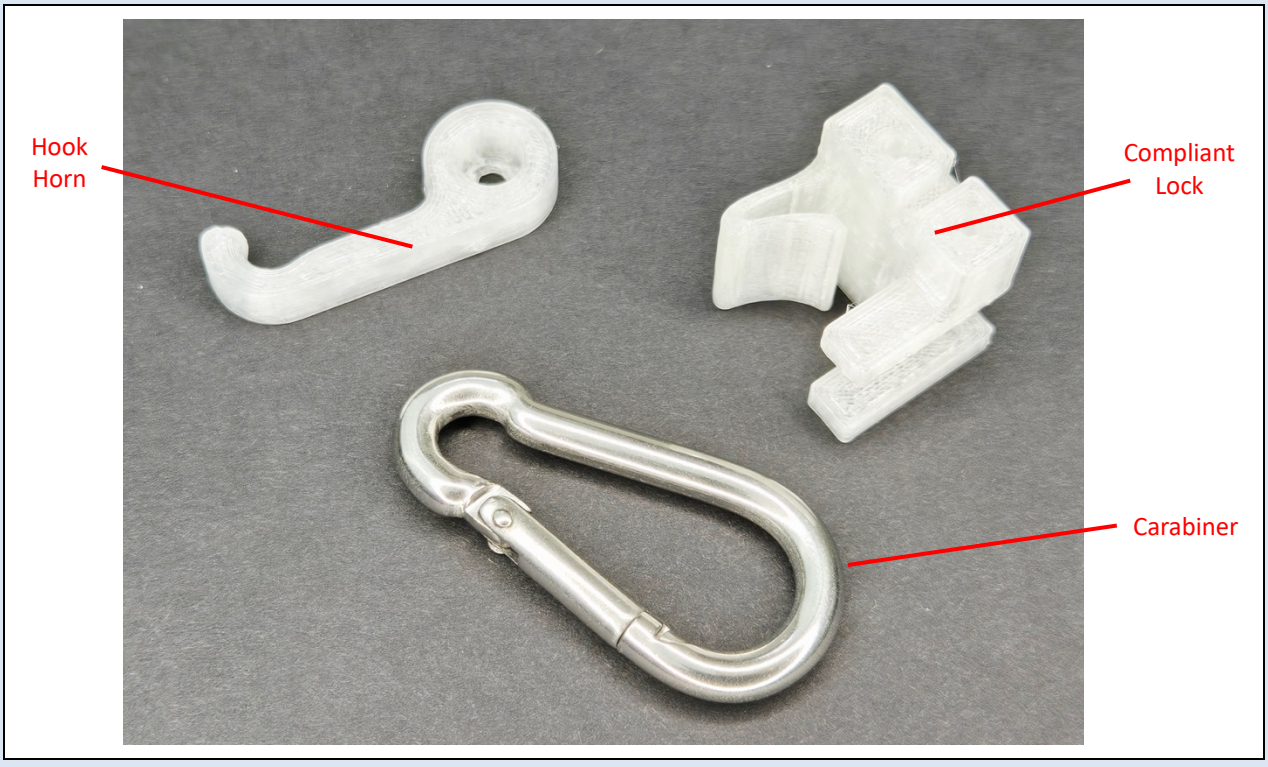
About Me: I'm a high school science teacher who loves outdoor education and adaptive camping programs. I have limited hand function due to a spinal cord injury (C6 level), but I maintain good wrist control and can operate larger controls.

My Challenge: During outdoor activities and lab work, I need to secure and release equipment like water bottles, tools, or safety gear. Traditional carabiners require pinching motions I can't perform reliably, especially when wearing gloves or when my hands are cold.

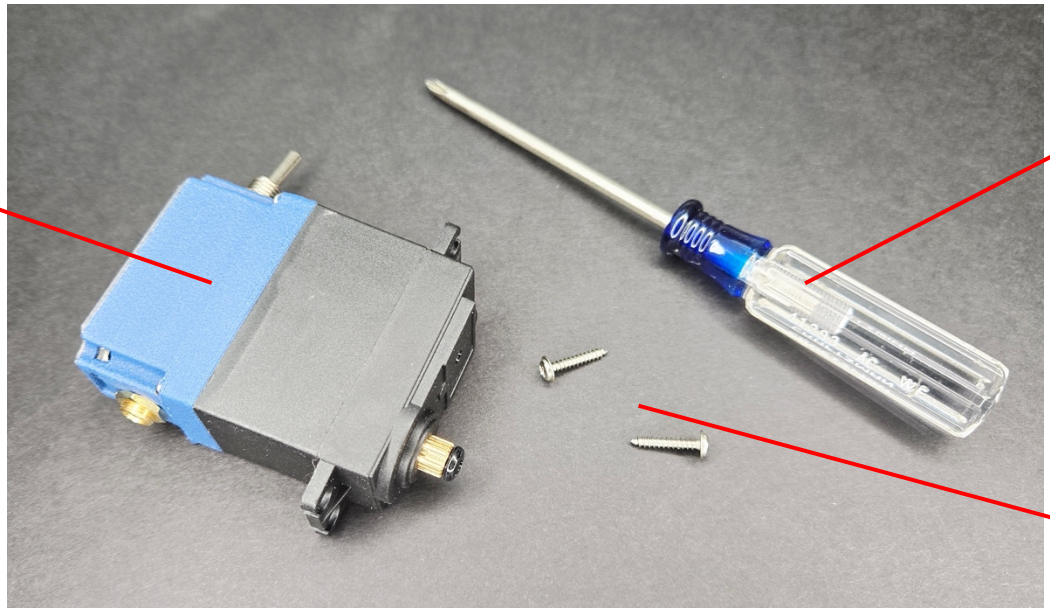
Technical Need: An automated carabiner system that can securely hold items and release them only when I choose, operated by accessible controls rather than fine motor manipulation.

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

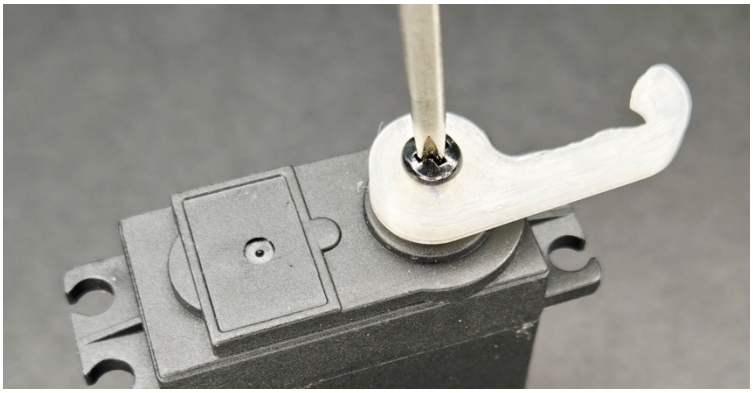
STEP 1: Lay out all the components that are new in this kit.



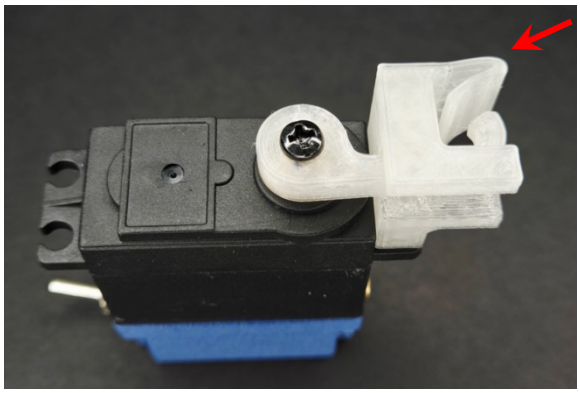
STEP 2: Make sure you have these items from your previous kits.



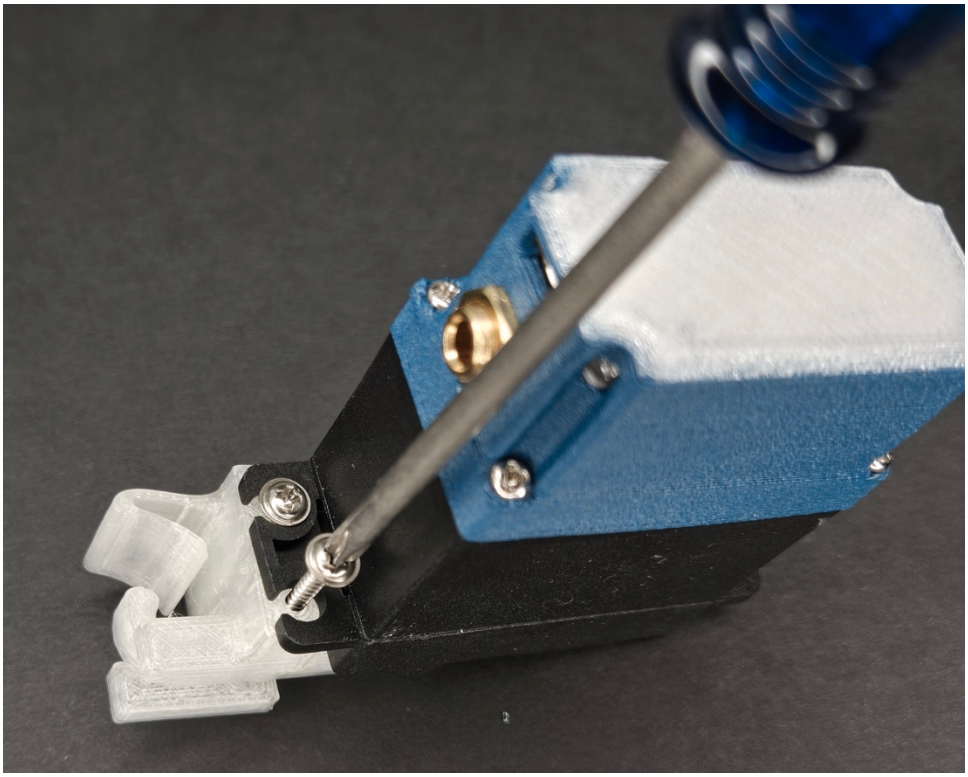
STEP 3: With the Smart Servo at 180 degrees, connect the Hook Horn as shown.



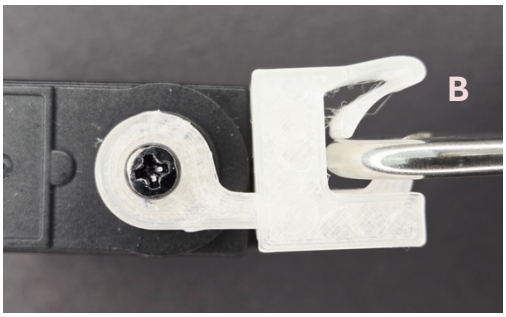
STEP 4: Slide the Compliant Lock over the mounting holes with the Hook Horn in between.

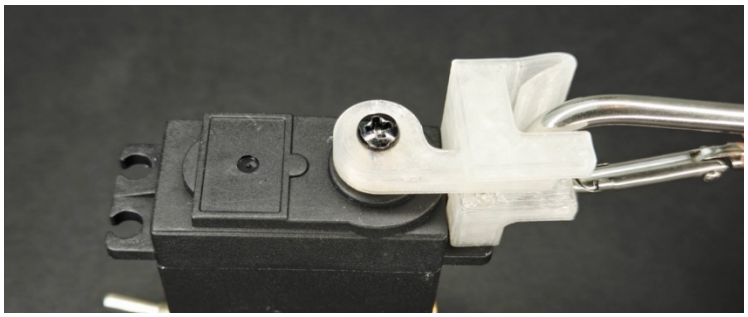


STEP 5: Use the Mounting Screws to secure the Compliant Lock.

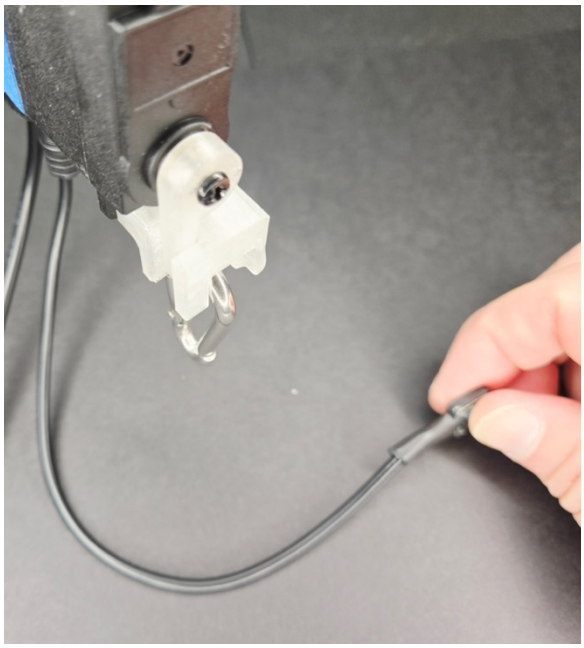


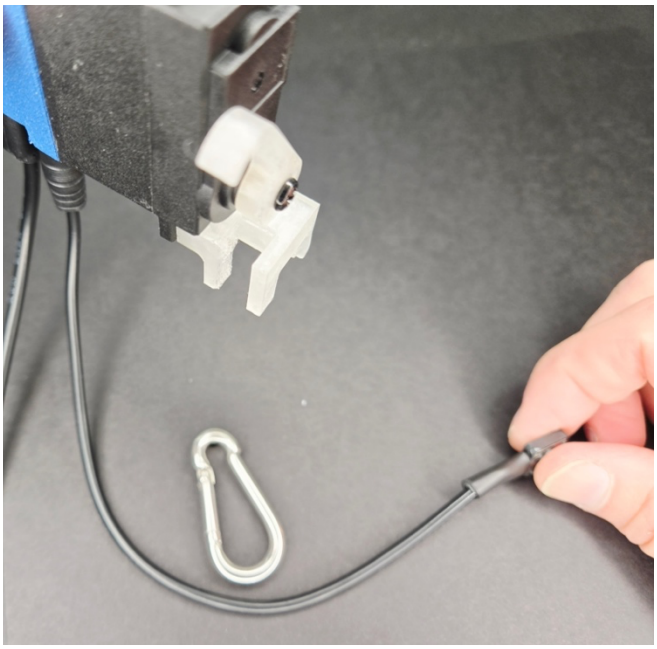
STEP 6: Push the Carabiner into the curved spring so that it begins to bend (A). Continue to push until the spring redirects the Carabiner against the Hook Horn (B). One in place, check to make sure that the Carabiner is held in place when rattled.





STEP 7: Connect the Smart Servo to power and a Test Button. Check that when the operated, the Hook Horn rotates and releases the Carabiner.





STEP 8: The Hook doesn't have to rotate much to release the Carabiner. Modify your code so that it just rotates the few degrees necessary for this release.

CONGRATULATIONS!

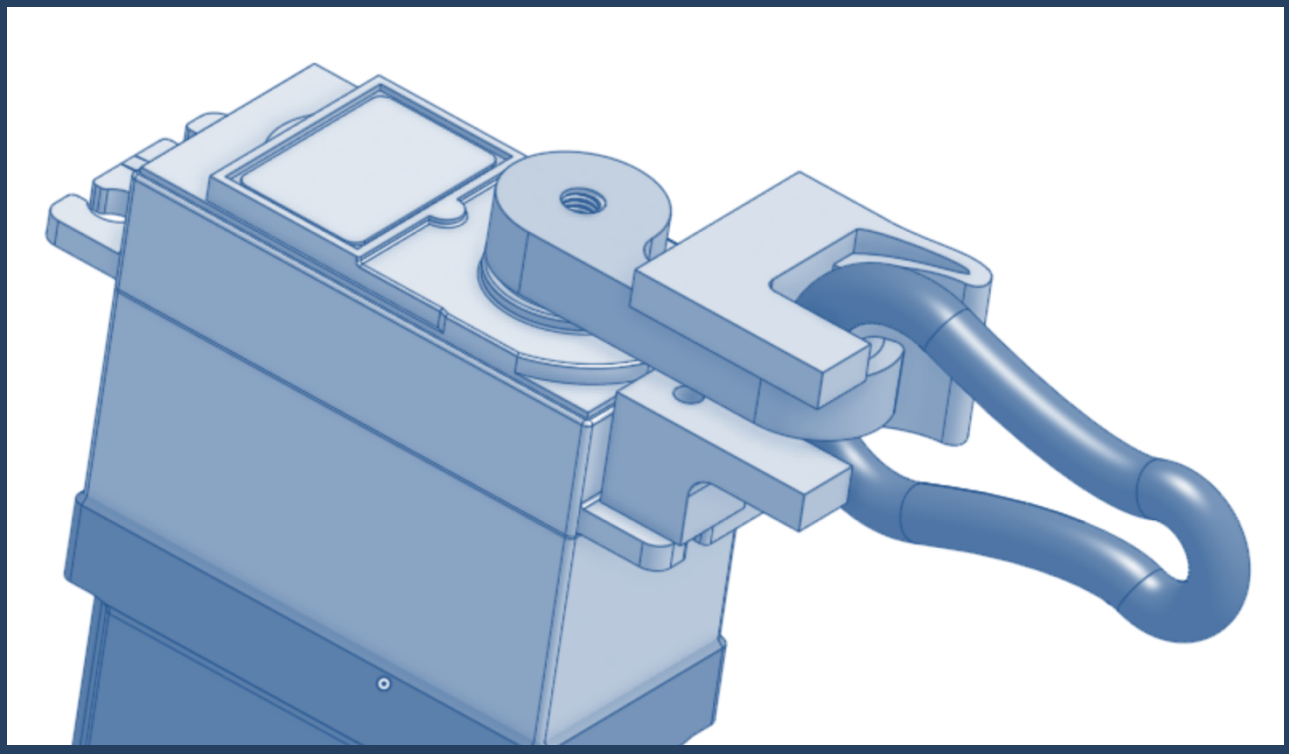
You just built an automated carabiner release system with smart locking. Next, we'll want to consider what needs to be done next to better assist Robert. Read his profile again and think about his outdoor education activities. What follow-up questions would you ask him about the specific equipment he needs to secure and release during lab work or camping trips?

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, you can download the 3D parts used in this project here: tinyurl.com/SS-STL-LOCK



THE BIGGER PICTURE

UNDERSTANDING COMPLIANT DESIGN IN YOUR CARABINER RELEASE

What is Compliant Design?

The spring mechanism in your carabiner release isn't made from a separate piece of metal - it's built directly into the 3D printed part itself! This approach is called compliant design or compliant mechanisms. Instead of using rigid parts connected by traditional joints like hinges or springs, compliant mechanisms use the flexibility of the material itself to create motion and store energy.

In your project, thin sections of plastic flex like springs when the carabiner is pushed into place, then spring back to hold it locked. The same piece of material that forms the rigid structure also provides the springy action - all printed in one continuous piece.

Why Compliant Design Matters

Compliant mechanisms are revolutionizing engineering across industries. Traditional machines require assembly of many parts - springs, hinges, bearings - each of which can wear out, require lubrication, or fail. Compliant designs can replace dozens of parts with a single piece, reducing manufacturing costs, eliminating assembly time, and creating more reliable products with fewer failure points.

You'll find compliant mechanisms everywhere: flexible hinges on flip-top bottles, snap-fit closures on plastic containers, and precision instruments like atomic force microscopes. Medical devices especially benefit because single-piece mechanisms sterilize more easily and have fewer places for bacteria to hide.

The Science Behind Flexibility

Designing compliant mechanisms requires mechanical engineering calculations about stress, strain, and material properties. Every material has limits: bend it too far or make it too thin, and it breaks; make it too thick, and it won't flex at all. Engineers must ensure parts stay below the material's yield strength - the point where permanent deformation or breakage occurs.

When you bend something, the outer surface stretches (tension) while the inner surface compresses. For your 3D printed spring, the plastic can bend repeatedly within a certain range without breaking, creating elastic deformation.

From Simple Springs to Complex Motion

Your carabiner release uses one of the simplest compliant mechanisms - a living hinge that acts like a spring. But compliant design can create much more complex movements. Engineers have designed compliant mechanisms that transform rotary motion into linear motion, create precise positioning systems for satellites, and even build entirely compliant robots with no traditional motors or joints.

NASA has designed solar panels and antennas that fold compactly for launch and deploy in space using compliant mechanisms. Researchers are creating soft robots made entirely from compliant materials that can squeeze through tight spaces or handle delicate objects - imagine rescue robots flexing through rubble to reach survivors.