2025

Lunzer Engineering Project: Rail Light

CAD +Mechanical Design
Solidworks
Bambu Labs H2D

Graham Lunzer

Project Overview

Objective

The goal of this project was to design removable rail-mounted systems for attaching a strobe flashlight and a green laser pointer to the right and left accessory rails of a water gun. The mounts needed to securely slide onto the existing rails while remaining removable, durable, and capable of withstanding sudden movement during active use.

Key Features

- Rail-mounted modular design
- Secure clamping system using locating screws
- Integrated cam-actuated laser switch mechanism
- Ball-detent locking system for positive engagement

Applications

This system is designed for recreational tactical water-based games where reliable accessory mounting and quick activation of lighting or aiming devices are required during movement.

Design Problem

Background

The user required a way to mount a strobe flashlight and a green laser pointer onto the existing rails of a water gun platform. Both accessories needed to remain secure during aggressive movement while still being removable for maintenance or repositioning.

Constraints

- Must slide onto existing accessory rails
- Limited design time (1-day deadline)
- Must withstand dynamic movement and vibration
- Components must be easily manufacturable via 3D printing
- Thread durability required for repeated assembly

Success Criteria

- Secure mounting during movement
- Reliable activation of the laser mechanism
- Minimal accessory movement inside mounts
- Clean, modular mechanical design

Stress and Load

Primary Load Conditions

- Dynamic loads from running, sudden stops, and rapid directional movement
- Repeated vibration and shock transferred through the rail system
- Minor static loads from accessory weight

Critical Stress Areas

- Rail mounting interface
- Flashlight housing contact surfaces
- Cam shaft in laser activation mechanism
- Ball detent pocket and spring interface
- Fastener mounting points

Design Solutions

- Tight rail interface secured with M5 locating screws
- Shim added to eliminate internal flashlight movement
- Adjusted tolerances in cam shaft and detent mechanism
- Threaded inserts used to prevent thread stripping in printed parts

Result

The final design distributes loads more evenly across the housing and mounting system, preventing accessory movement and improving durability under dynamic conditions.

Design Process

1 — Concept Sketches

Initial sketches explored simple rail clamp mechanisms and potential switch activation solutions for the laser pointer.

2 — CAD Modeling

All components were modeled in SolidWorks with tight tolerances to ensure precise rail engagement and reliable accessory alignment.

3 — Prototype Printing

Components were produced using a Bambu Lab H2D printer for rapid prototyping and immediate testing.

4 — Testing & Iteration

Functional testing revealed small tolerance issues in both the flashlight mount and the laser activation mechanism.

5 — Final Design

Clearances were adjusted and the mechanism refined, resulting in a stable, reliable mounting system.

Engineering Details

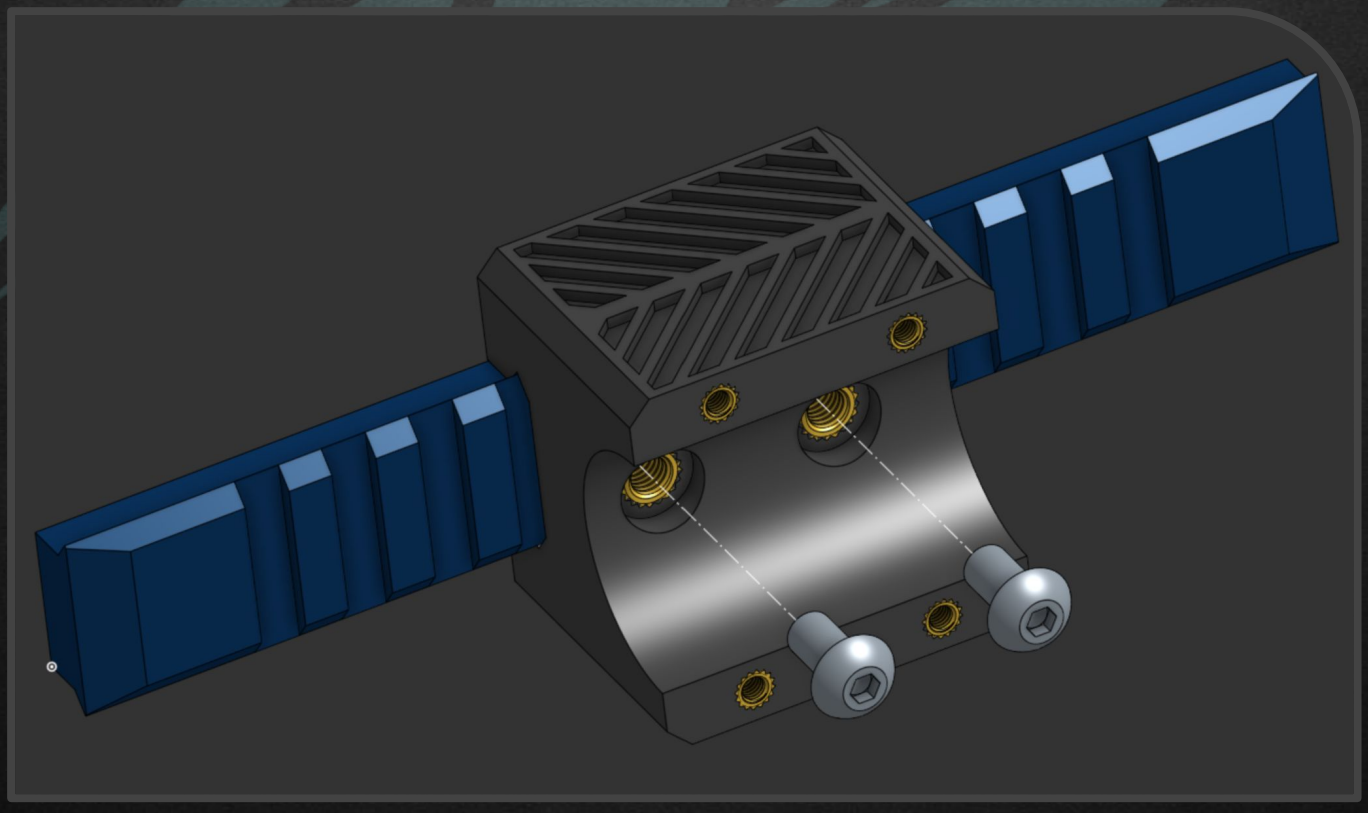
Specifications

Material:
3D printed polymer (PLA/PETG)

Mounting System:
Rail-slide base with locating screws

Fasteners:
- M5 locating screws (rail mount)
- M4 screws (flashlight cap)
- M3 screws (laser cap)
- Heat-set threaded inserts for durability

Manufacturing:
FDM 3D printing using Bambu Lab H2D



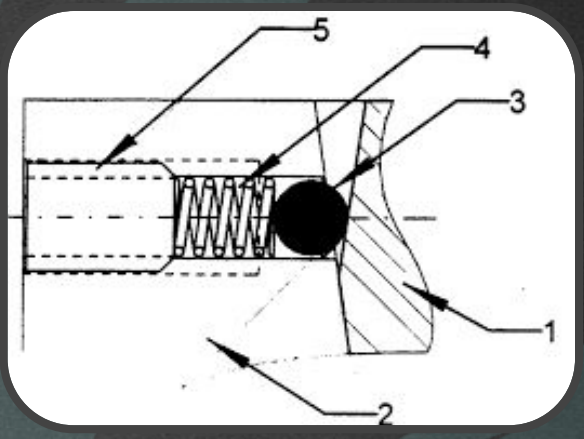
Mechanism Overview

Step-by-Step Operation

1. Mount base slides onto the existing rail system.
2. M5 locating screws secure the mount to the rail.
3. Flashlight is inserted into the housing and secured with a top cap.
4. Laser mount uses a cam mechanism to press the laser activation button.

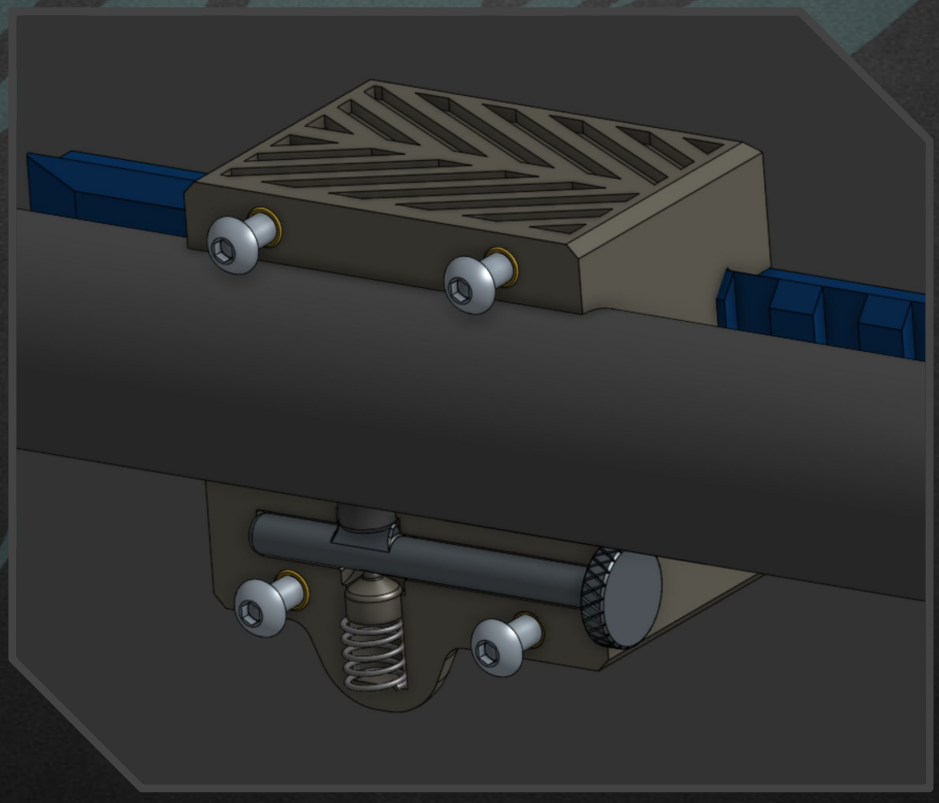
Key Mechanical Features

- Rail-slide mounting interface
- Cam-actuated button press mechanism
- Spring-loaded ball detent locking system
- Threaded inserts for long-term durability



Motion Description

When the cam is rotated upward, it presses the laser button and locks into position using a spring-loaded ball detent. Rotating the cam back disengages the button and turns the laser off.



Prototyping

Manufacturing Method

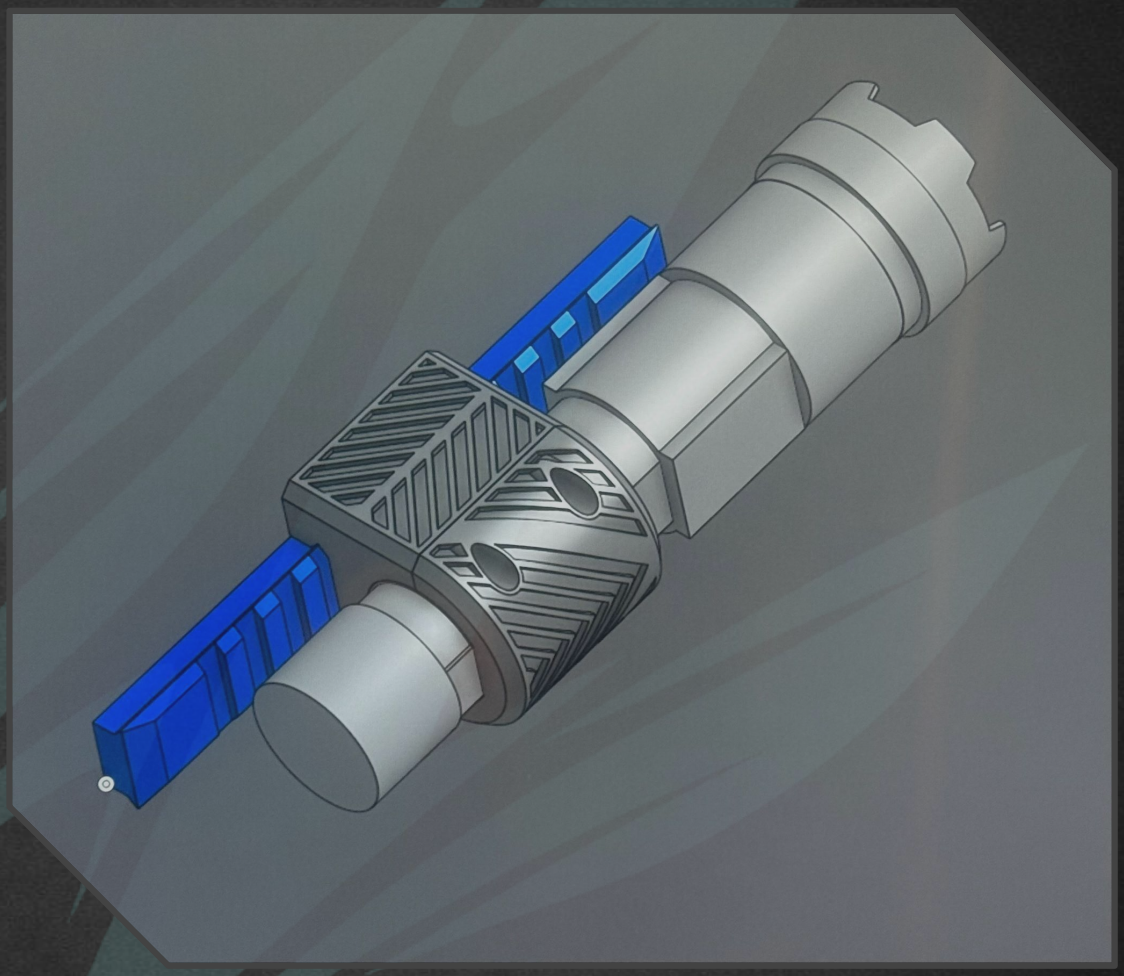
FDM 3D printing

Printer

Bambu Lab H2D

Materials

PLA / PETG



Notes

Threaded inserts were installed in all threaded features to ensure strong and durable connections for repeated assembly.

Iterations

Version 1

Flashlight mount was functional but had slight internal clearance that allowed the flashlight to shift inside the housing.

Version 2

A printed shim was added to wedge the flashlight firmly in place, eliminating internal movement.

Laser Mechanism Iteration

The first version of the cam and detent system had tolerances that were too tight, causing binding. Adjustments were made in CAD to increase clearance between the camshaft and detent spring, resulting in smooth operation.

Key Improvements

- Eliminated flashlight movement with shim insert
- Reliable cam-actuated laser switch
- Positive locking ball-detent mechanism
- Strong threaded inserts for durability

The final system securely mounts both accessories to the water gun platform and withstands dynamic movement during active use.

Project Outcome

Performance

The final design performed reliably during testing and real-world use. Both accessories remained securely mounted, and the cam-actuated laser switch provided consistent engagement.

Lessons Learned

Precise tolerance control is critical when designing mechanisms involving springs, detents, and rotating components.

Future Improvements

- Integrate adjustable tolerance features for accessory fitment
- Reduce part count through integrated housing geometry
- Explore stronger materials for long-term durability