

# Insulation Attachment Device for Astronaut Use on the ISS: The Backyardigans NASA Tag Gun

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## ABSTRACT

The Backyardigans aim to create a safe, ergonomic, and reliable tool to be used by astronauts to attach two layers of insulation while on a spacewalk. With the restriction of only being able to access the exterior of these two panels, the team pursued creating a tag gun, capable of inserting as many tags to hold the layers together as needed, while being easy to operate.

## PROJECT BACKGROUND

Soft goods, or textiles, serve several crucial functions in spaceflight such as thermal protection and shielding for sensitive equipment. This Micro-G challenge involves devising a method of installing softgoods during spaceflight, where astronauts only having access to the exterior-facing side of the material, not having the ability to reach around the desired surface and having limited dexterity from wearing pressurized gloves.

## OBJECTIVES

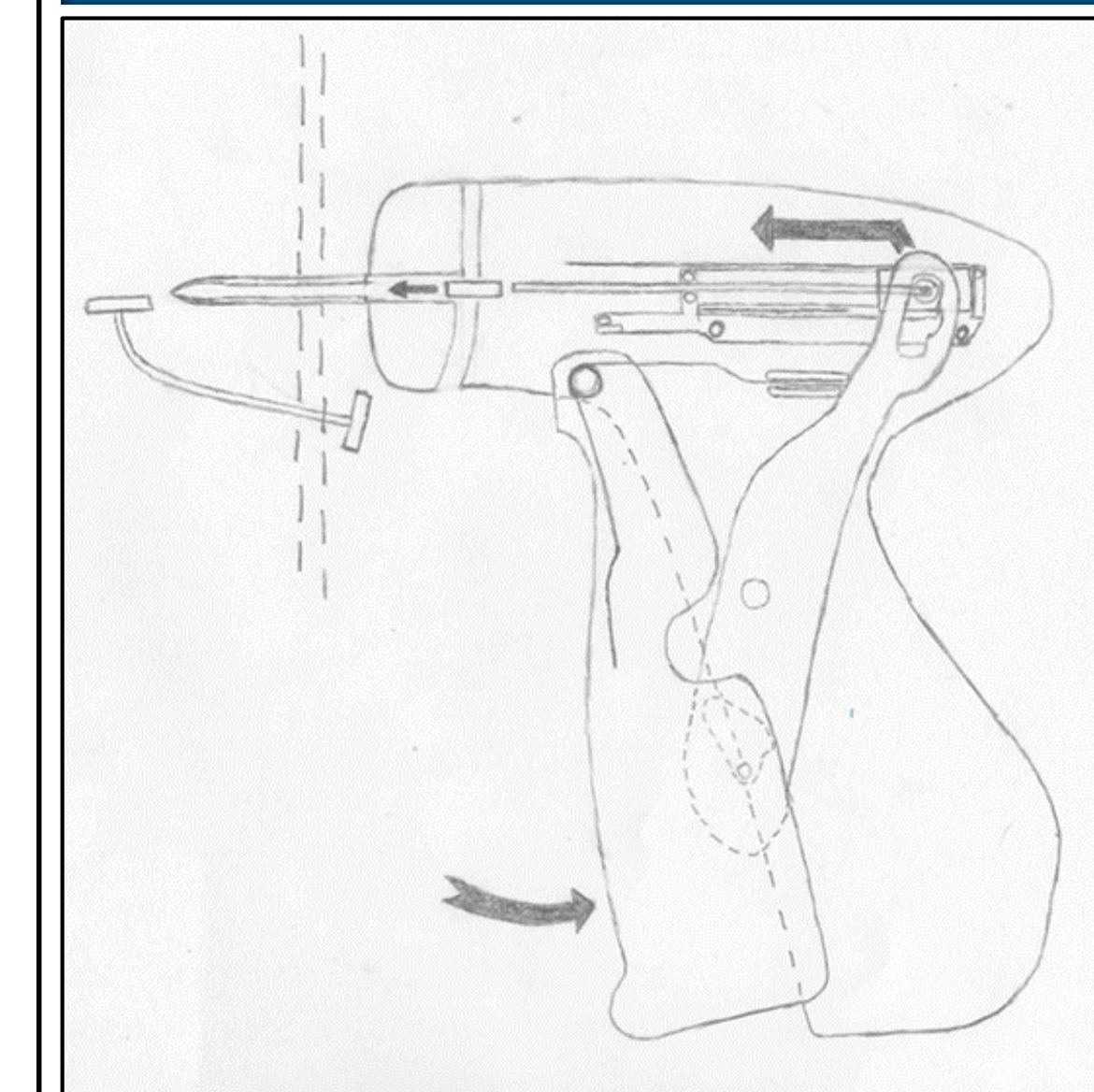
To design a manually operated tool for attaching two softgoods materials together with access to only the exterior side.

The softgoods attachment device must:

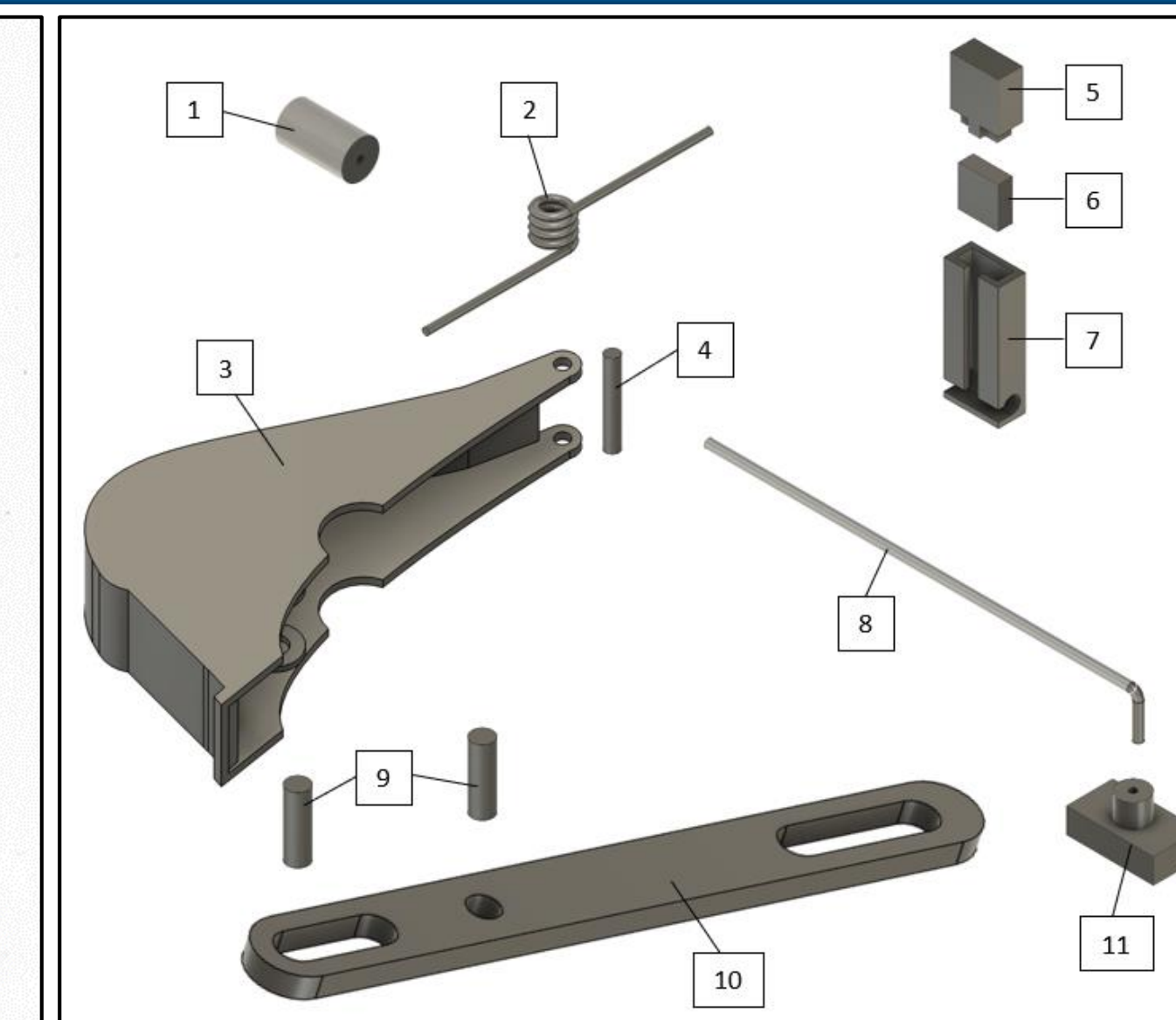
- Weigh a maximum 10 lbs
- Have an undeployed volume of  $\leq 1 \text{ ft}^3$
- Resist a bump load of 30 lbf
- Have a linear actuation force of  $\leq 20 \text{ lbf}$  or
- Have a rotating actuation force of  $\leq 30 \text{ in-lb}$
- Meet or exceed a factor of safety of 2
- Be made from approved materials

## RESULTS & DISCUSSION

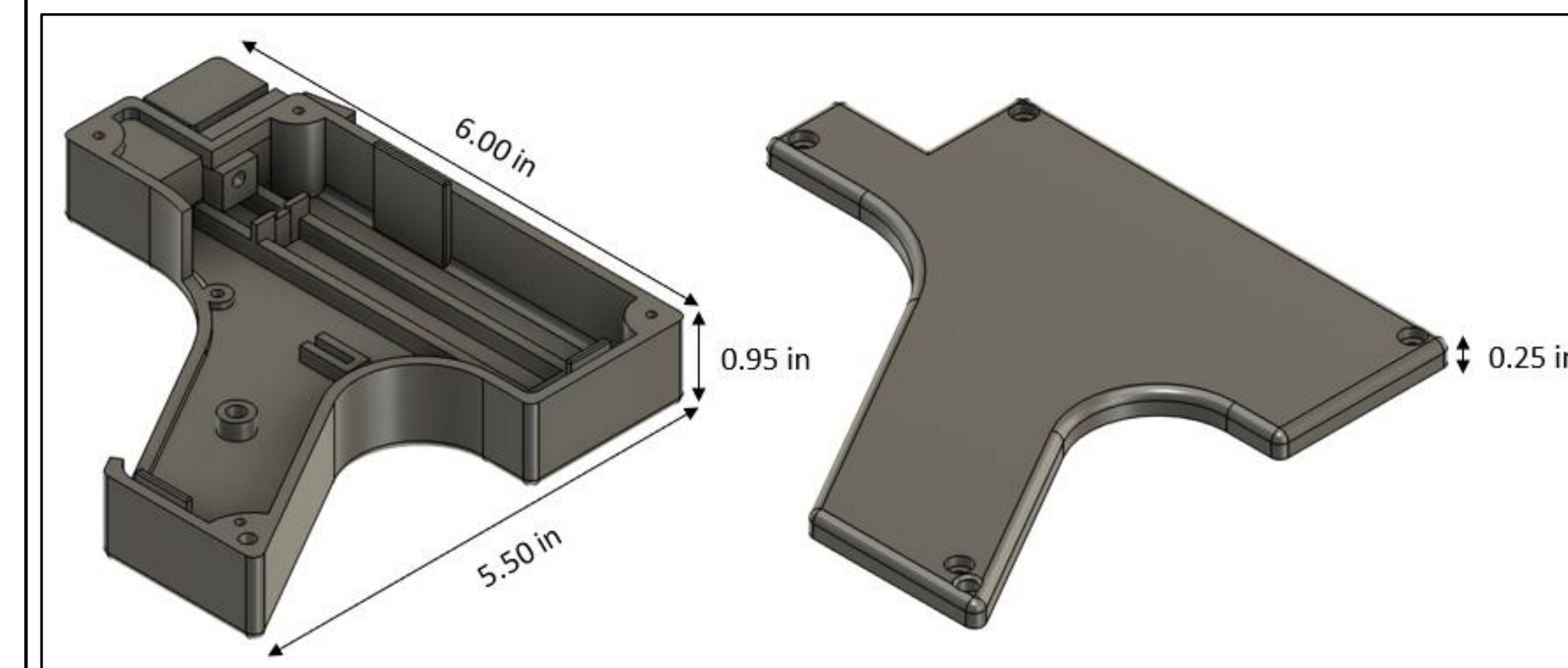
### Final Design Description



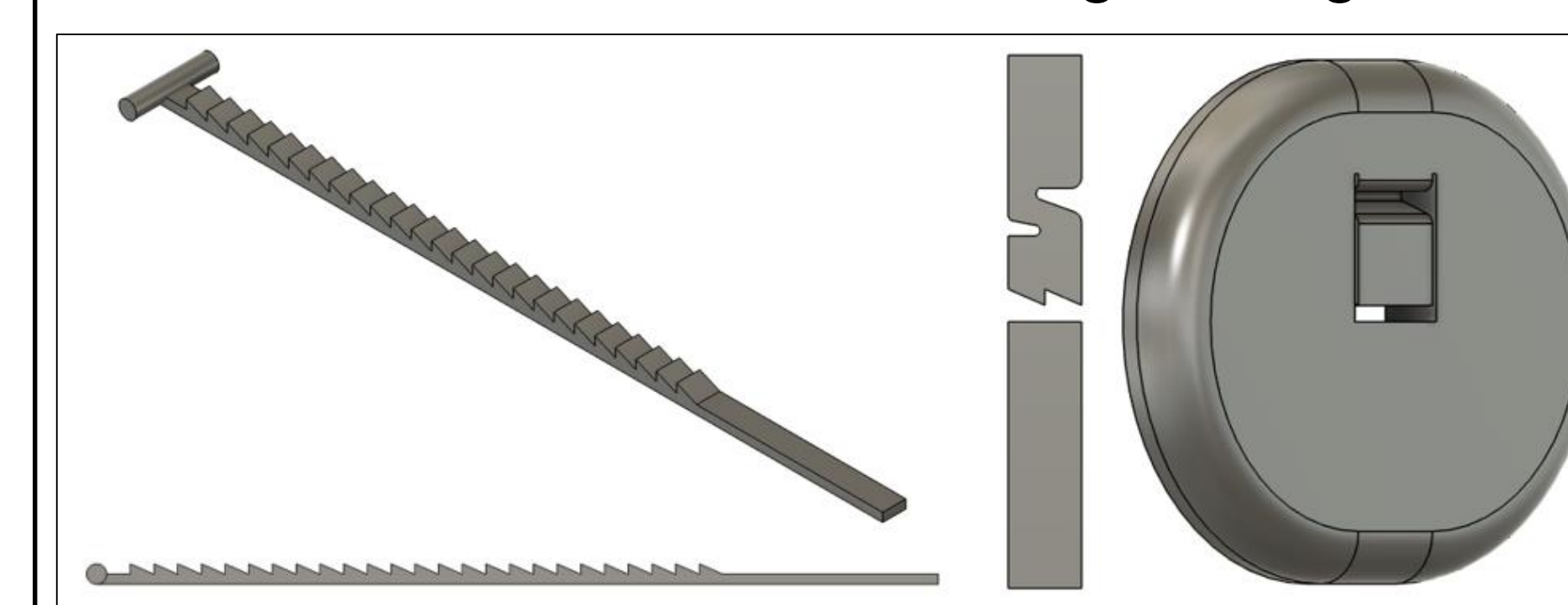
Final Concept: Tag gun



Internal Components

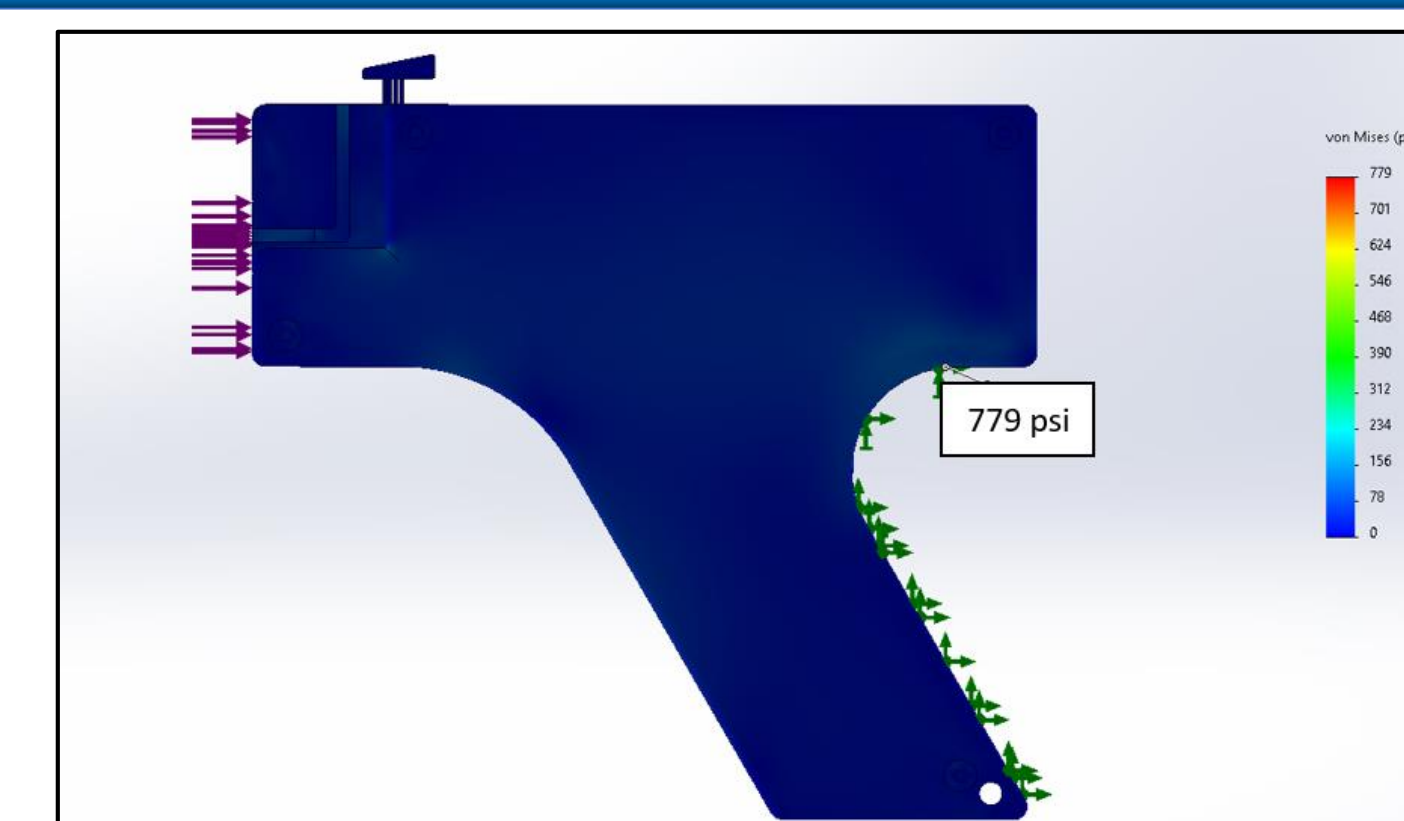


Housing/Casing



Tag Attachment Concept

### Analysis and Testing



Moment of Inertia,  $I$

$$\frac{bd^3 - h^3(b-t)}{12}$$

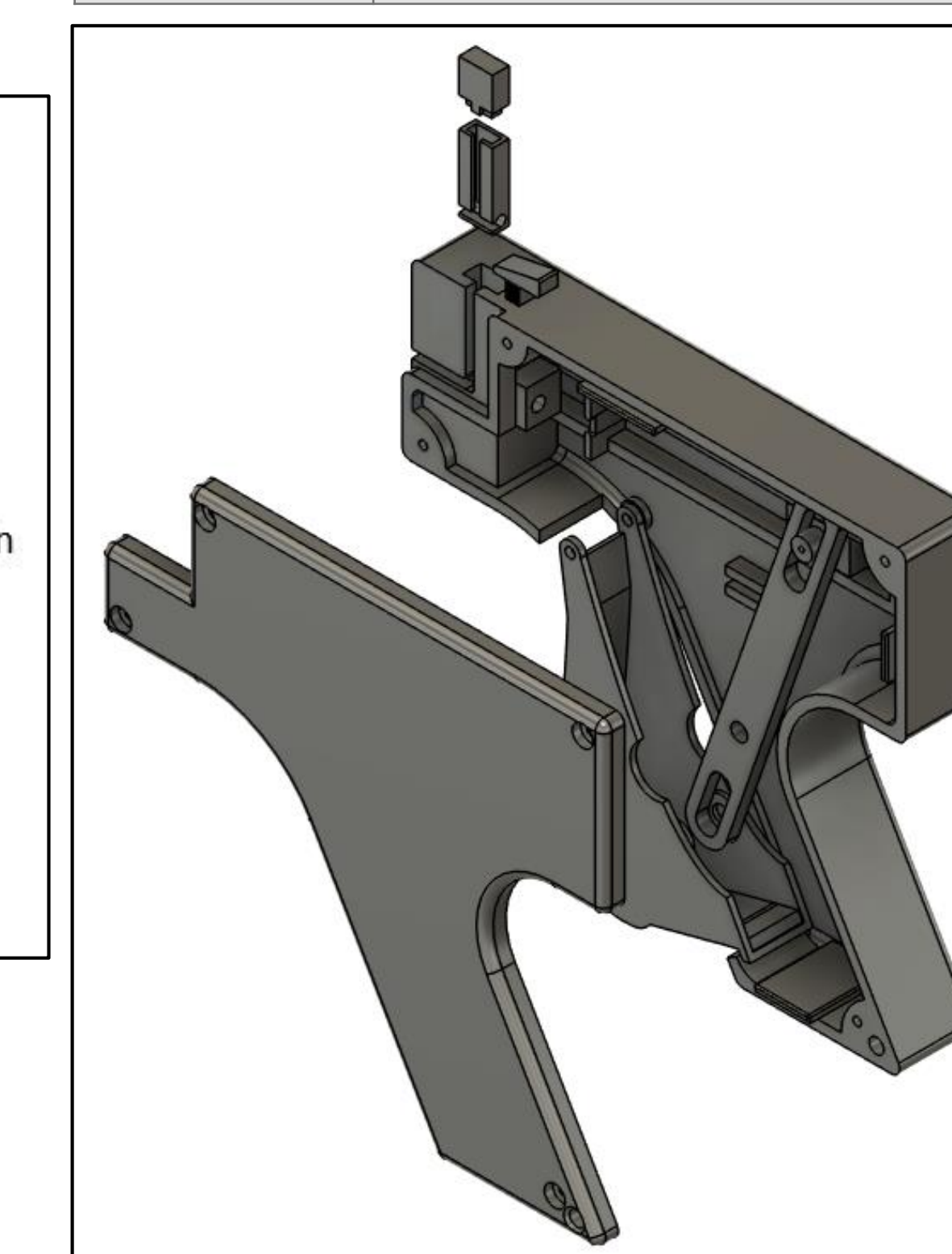
Between support and load,

$$s = \frac{W}{Z}(l-x)$$

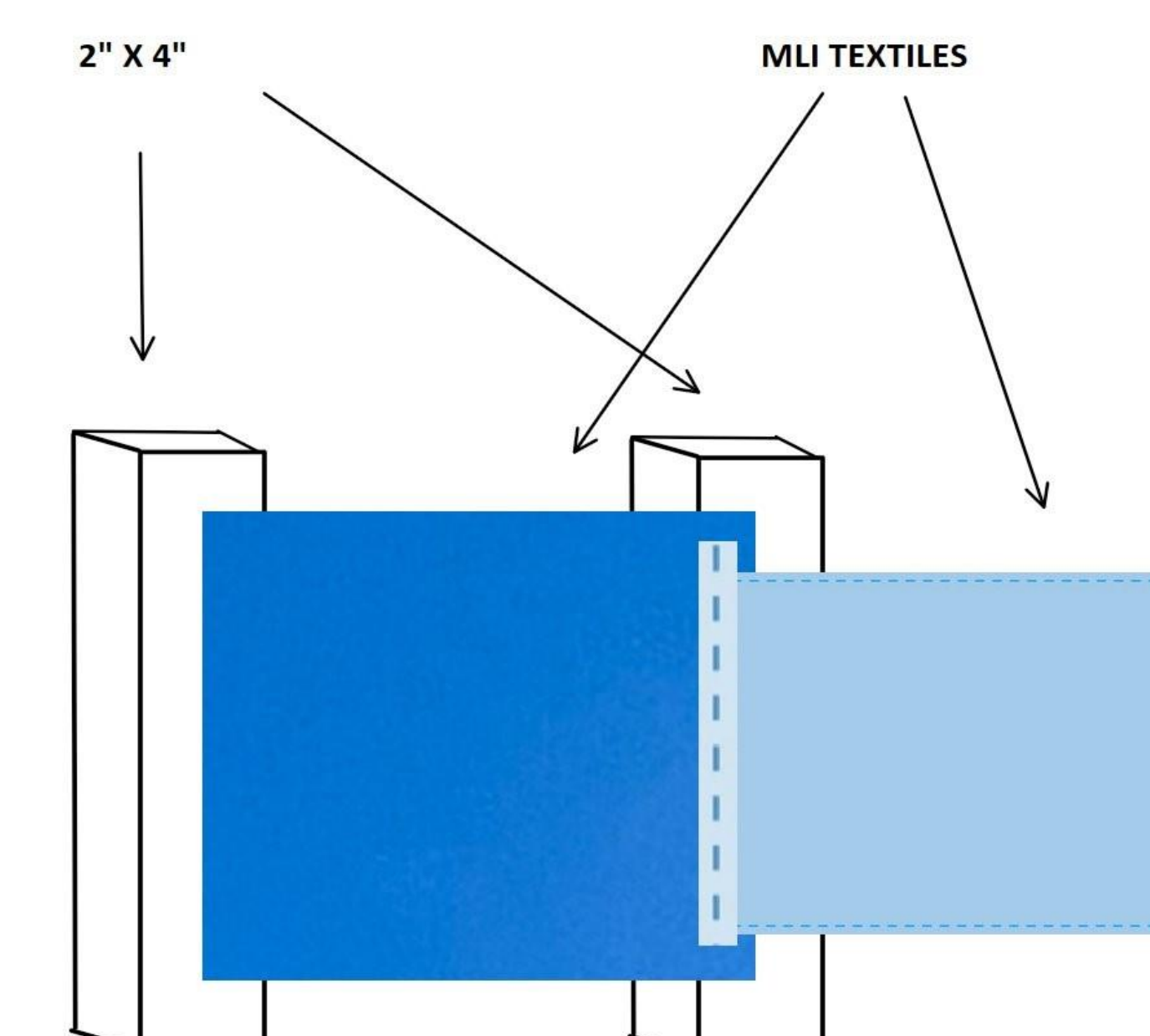
$$\sigma_{\text{total}} = \sigma_a + \sigma_b$$

### Core Components

Item No.	Part
1	Needle Collet
2	Trigger Spring
3	Trigger Handle
4	Handle Pivot Pin
5	Magazine Cap
6	Magazine Plate
7	Magazine Body
8	Plunger
9	Lever Arm Pivot Pins
10	Lever Arm
11	Slider



CAD Assembly



Functional Test Set up

### Stress Calculations

- Stress calculations are done on the most critical point of the tag gun case
- Considered an applied load of 30 lbf
- Resulted in 970 psi
- Tough PLA has a yield strength of 6,570 psi
- Safety factor of 6.7

## FUTURE WORK

Up to this point, the teams focus was put towards accomplishing the primary project objectives. There are plans to explore implementing either a removeable cap, or a retractable sleeve around the needle to minimize exposure to sharps.

The current tagging attachment design is difficult to reliably manufacture with the team's current means and tools available. Injection molding would be the preferred method of production for this tag design to meet the precise dimensions and flexibility required for the attachment and for the tool to deploy.

## CONCLUSIONS

The design of the Backyardigans Tag gun met all objectives that were set out at the beginning of the planning stage. The team worked together to choose the most suitable design and create a suitable foundation to begin prototyping. The final design of the tag gun will stand apart from other designs due to its ergonomics and ease of use, along with the ability to create as many connections as needed while taking up minimal space and weight.

## ACKNOWLEDGEMENTS

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