The Backyardigans: Softgoods Attachment Device

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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 in space. With the restriction of only being able to access the front 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 very 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

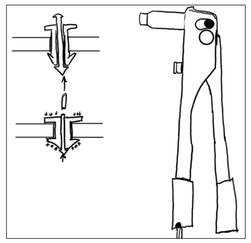
To design a manually operated tool for attaching two softgoods materials together with access to only the exterior side.

The softgoods attachment device must:

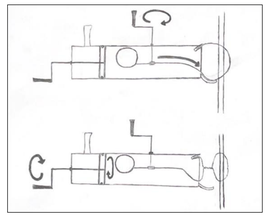
- Weigh a maximum 10 lbs
- Have an undeployed volume of $\leq 1\ ft^3$
- Resist a bump load of 30 lbf
- Have a linear actuation force of $\leq$ 20 lbf or
- Have a rotating actuation force of $\leq$ 30 in-lb
- Meet or exceed a factor of safety of 2
- Be made from approved materials

RESULTS & DISCUSSION

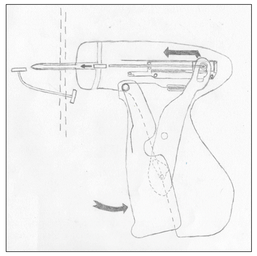
Conceptual Design and Selection



Concept 1. Rivet gun



Concept 2. “Crank and Twist”



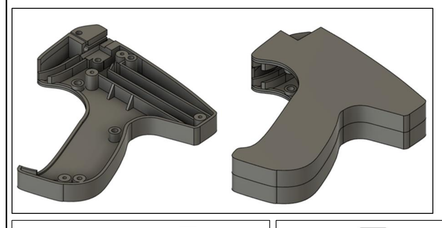
Concept 3. Stitch gun

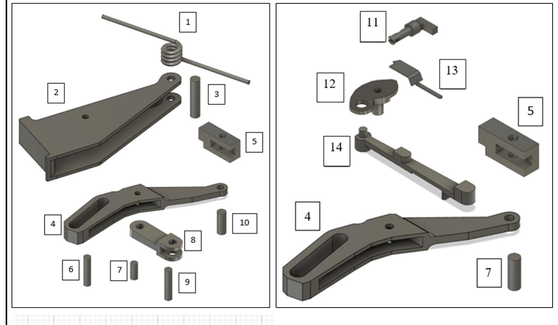
Selection Criteria	Weight	Rivet Gun	Crank and Twist	Stitch Gun
Safety	5	5	5	4
Ergonomics	5	4	3	5
Maintenance	1	2	1	2
Weight	3	2	1	3
Size	2	2	2	3
Durability	4	2	1	2
Reliability	5	3	2	3
Actuation Force	3	3	2	4
Time to Use	2	2	1	3
Net Total		93	70	103
Rank		2	3	1

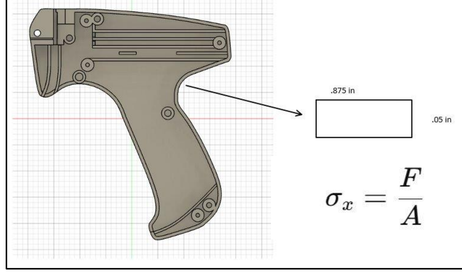
Key Notes:

- Concept 1 is simple and safe but heavy and requires more force.
- Concept 2 would be more complex and therefore more expensive to make with more potential points of failure.
- Concept 3 is simple and effective, but potentially less safe.

Modeling and Analysis







$$\sigma_x = \frac{F}{A}$$

Core Components

Item No.	Part
1	Trigger Spring
2	Trigger Handle
3	Primary Handle Pin
4	Primary Lever Arm
5	Primary Slider
6	Lever Arm Sliding Pin
7	Lever Arm Connecting Pin
8	Secondary Lever Arm
9	Secondary Lever Arm Pin
10	Primary Slider Pin
11	Needle Lock
12	Cycle Lever
13	Cycle Plate
14	Secondary Slider

Preliminary Stress Calculation

- Stress calculations are done on the most critical point of the tag gun
- Considered an applied 30 lbf
- Resulted in 685.7 psi
- Tough PLA has a yield strength of 6570 psi
- Thus, it will not fail and has a safety factor of roughly 9.5

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 main work to come next semester would be to create the first prototype and proceed with testing. Special areas of interest include testing the ergonomics of the gun, as well as ensuring each connection can be made free of error.

In the coming semester, the team aims to improve and verify their stress analysis by using Finite Element Analysis (FEA).

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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