Passive Capture Tool Dock (PCTD)

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ABSTRACT

During Extravehicular Activities (EVA's), astronauts use the Pistol Grip Tool for essential maintenance tasks. The current Bayonet and Tether system used for securing this tool requires visual confirmation and two-handed operation, increasing the risk of tool loss. To address this issue, Team Interstellar Innovators designed the Side Release Buckle, a compact and easy to use docking system that allows one handed operation without visual checks. This design improves safety, saves time, and makes tool handling more efficient during spacewalks.

Project Background

Losing tools and materials in space can be extremely hazardous for astronauts, the International Space Station, and even for other orbiting satellites.

Currently NASA uses a tool called the Bayonet to secure tools to the astronaut. This device is not single fault tolerant and requires additional tethers to safely secure tools in the event of a component failure.

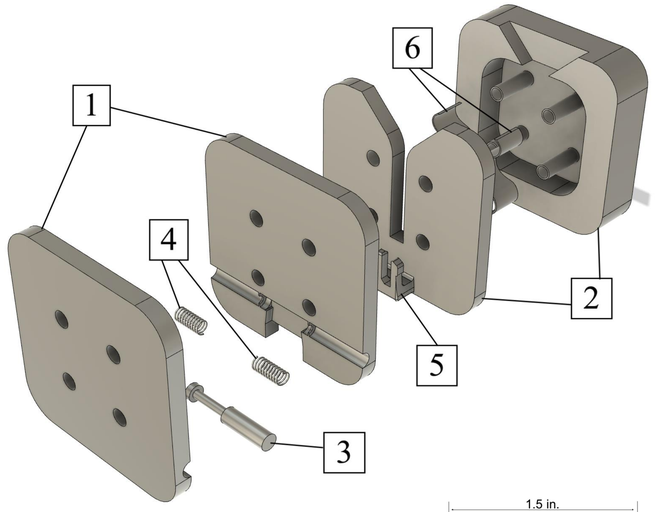
To better secure tools and materials during EVAs NASA is looking for alternative methods to secure the Pistol Grip Tool (PGT) one of the largest and most frequently used tools used by astronauts.

Objectives

To design a Passive Capture Tool Dock that safely and securely holds the Pistol Grip Tool, while the following requirements are met.

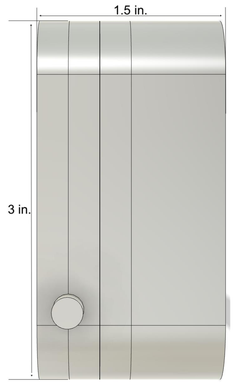
- Blind and One-Handed Installation
- Ergonomic
- Holds at least 15 lbs.
- Less than 10 lbs. and 1.5 lb-in install forces
- Operable in constrained body positions
- Single fault tolerant

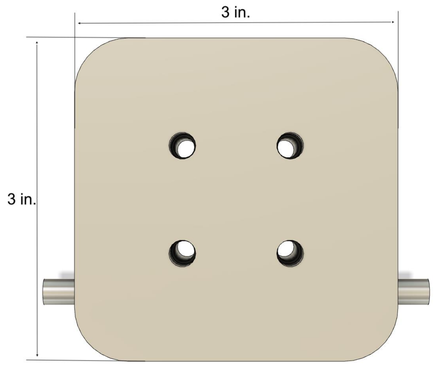
RESULTS & DISCUSSION

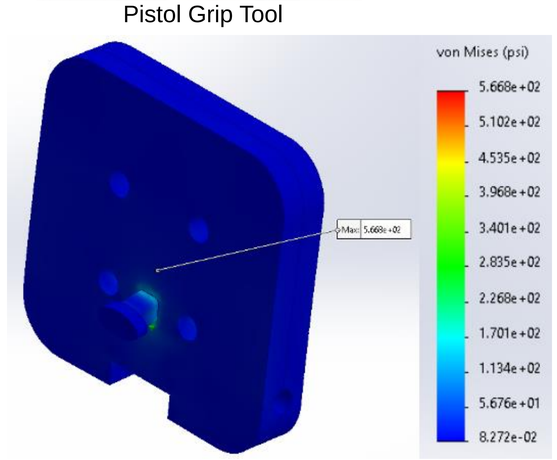


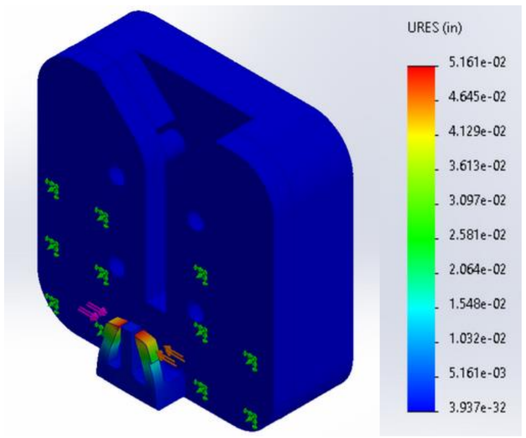
Item No.	Part
1	Body of Tool Component
2	Body of the Belt Component
3	Buttons
4	Springs
5	Buckle
6	Curved Flat Springs

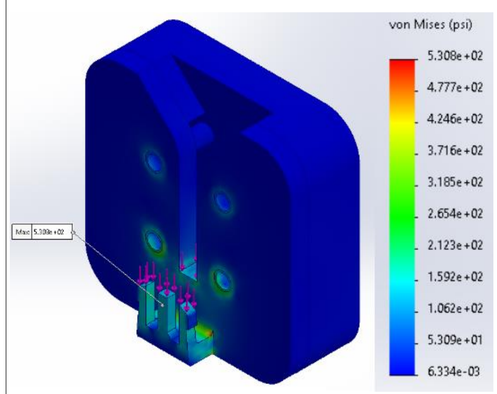
Pistol Grip Tool



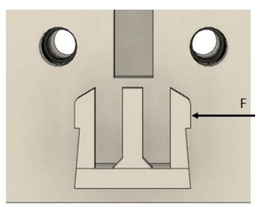








Button and Buckle Analysis



Assuming simplified geometry for the Buckle

$$M = F \times d$$

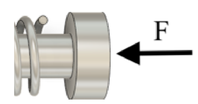
$$M = 10\ lb \times 0.5in$$

$$M = 5in.lb$$

$$\sigma_B = \frac{My}{I}$$

$$\sigma_B = \frac{5in.lb \times 0.49in}{\frac{1}{12} \times 0.125in \times 0.98^3 in^3}$$

$$\sigma_B = 25.0\ kpsi$$



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

$$\sigma_x = \frac{10}{\frac{\pi}{4} \cdot (0.125)^3}$$

$$\sigma_x = 6.5kpsi$$

FUTURE WORK

The current PCTD has some enduring sharp edges that the team is working on reducing while ensuring the function of the design is unchanged.

The PCTD will enter the prototyping phase with various stages of 3D printing to verifying geometries, tolerances, and ensuring the product remains within customer requirements.

Prototyping will begin with 3D printing the part in PLA to test tolerances and verify manufacturing. Then the construction of the curved flat helical springs will take place. Once everything is verified a final print with tough PLA will be produced to begin product testing.

CONCLUSIONS

The Side Release Buckle was successfully designed to meet NASA's objectives by allowing one-handed tool docking without visual confirmation. It supports loads over 15 lbs. with a factor of safety above 2.0, while remaining below the 2 lb. weight limit. The compact design is ergonomic and compatible with EVA gloves for ease of use. Overall, the design meets NASA's goals for improving astronaut safety, efficiency, and reliability during spacewalks.

Acknowledgements

Team Interstellar Innovators would like to acknowledge

- Texas Space Grant Consortium for sponsoring this design challenge
- Dr. Billah as our faculty advisor for his guidance towards task completion
- Scott Harper for photo and video editing

References

Email Cal Harper for any questions (HarperC2356@uhcl.edu)

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