The University of Texas at TYLER

HEC 23: Vanguard

Dept. of & Mechanical Engineering

xEMU Space Suit Quick Release and Catch System

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Sponsor: NASA Texas Space Grant Consortium, Micro-G NExT
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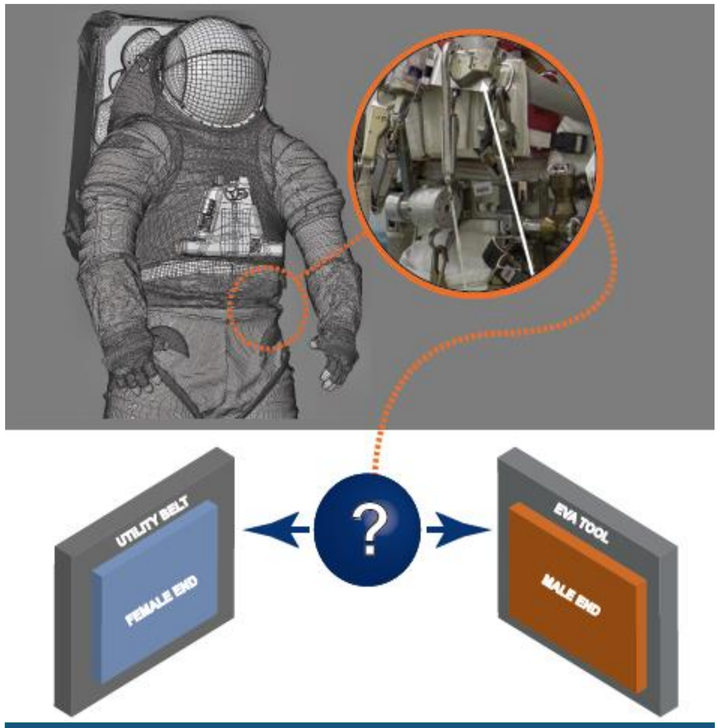
Background

The federal government has directed NASA to return humans to the moon by 2024. Artemis III is scheduled to launch October 2024 where the actual lunar landing mission will take place with NASA's first female astronaut and next man to land on the moon. NASA will touchdown on the south pole region of the moon where astronauts will be mining for ice.

Objective

1. Design two interlocking components with a quick release for a space suit utility belt which secures tools required for space walks.
2. The quick-release mechanism will need to be manually operated in micro-gravity, and functional in extremely cold environment.
3. The mechanism must function in the presence of lunar dust and are required to mate as shown below.

Overview of Belt Interaction



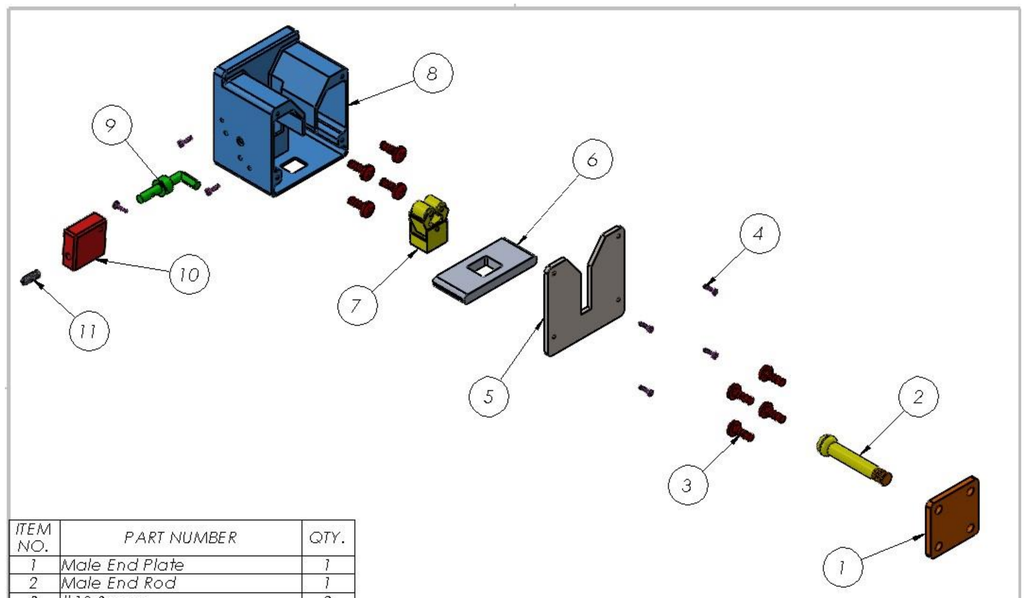
NASA TSGC Fall Showcase 2020 Awards

Top Design Team – 1st Place
Best Poster – 1st Place
Best Peer Review – 2nd Place

Abstract

Astronauts exploring the lunar surface will perform a series of Extravehicular Activities (EVA), which require repeated access to various tools and equipment installed on the Exploration Extravehicular Mobility Unit (xEMU). Carrying tools on the xEMU will improve spacewalk efficiency during end-to-end sampling missions. Tools must interface with the spacesuit through a manually operated and lunar dust-tolerant mechanical subsystem. Therefore, two interlocking components with an integrated double roller catch are designed out of Teflon, Aluminum 6061, and AISI-316L steel to facilitate removal and reattachment of fit-for-purpose tools. Compared to NASA's previous bayonet probe design, the Vanguard xEMU subsystem safely stows and secures various tools required for lunar surface exploration and provides adequate lunar dust mitigation for proper functionality. The design will be part of several student-inspired solutions to NASA's present-day challenges for the upcoming 2024 Artemis Mission to the Moon and beyond to Mars.

Vanguard xEMU Quick Release and Catch System

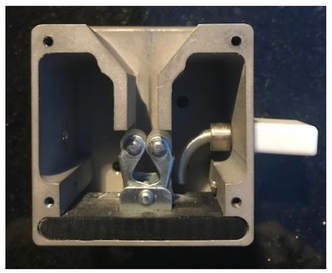


ITEM NO.	PART NUMBER	QTY.
1	Male End Plate	1
2	Male End Rod	1
3	#10 Screw	8
4	#2 Machine Screw	7
5	Quick Release Cover Plate	1
6	Roller Catch Bottom Plate	1
7	Double Roller Catch	1
8	Quick Release Female End	1
9	Safety Lock Inner	1
10	Safety Lock	1
11	Ball-Nose Spring Plunger	1

TITLE: Quick Release Assembly Exploded View
SIZE A | DWG. NO. | REV
SCALE: 1:2.25 | WEIGHT: | SHEET 1 OF 1

Quick Release – Male End

Double Roller Catch Mechanism



Quick Release Attachment - Assembly

Design Specifications

Specification	Value / Limit	Unit of Measure	Analysis Method
Load capacity	Minimum of 15	English Pounds	Weight Dynamometer
Assembly Volume	Maximum of 48	Cubic Inches	Fits within 4″ x 4″ x 3″ box
Assembly Weight	Maximum of 2	English Pounds	Analytical Balance
Materials of Composition	Aluminum 6061 Aluminum 7075 Stainless Steel Teflon	Alloy Composition Verified	ASTM B209 AMSQQ-A-250, ASTM B209 ASTM A240 ASTM D3294
Fastener Diameter	Equal to 0.201	Inches	Digital Calipers
Fastener Type	#10 ANSI	Screw	ASME B18.6.3
Bolt Interface Pattern	4-hole square arrangement	Inch Squared	Digital Calipers
Actuation, Stability (force to install and separate)	Minimum of 6	English Pounds	Force Dynamometer

Specification	Value	Analysis Method
Field of View	Must operate within and outside of astronaut line-of-sight	Functions as intended without direct line-of-sight
Single-Hand Operation	Quick-release engages and disengages single handedly	Use of second hand only for tool placement
Resistance to Debris	Lunar dust/regolith will not impede operability	Must operate as designed after being fully submerged in lunar dust simulant, cycled 10 times
Dexterity	Device operable with EVA gloved hands	Actuated with gloved hands (e.g. heavy ski gloves)
Power Method	Manual	Hand-Actuated
Safety (Cutting)	Sharp Edges, Minimized	Beveled/smooth edges
Safety (Hand 1)	Pinch Points, Minimized	Labeled with ⚠ if present
Safety (Hand 2)	Eliminate potential for entrapment of fingers	No accessible holes or openings that act as finger trap

Conclusion

The Vanguard xEMU Quick Release and Catch System increases the efficiency of a spacewalk by enabling a quick, smooth, and repetitive process for astronauts to connect and disconnect tools needed on EVAs. The subsystem passed most of the major qualification tests. This included weight-up testing, stability testing with various tools, ease of operation by a gloved hand when installed on a utility belt, and confirming functionality with lunar dust simulant. The device remained functional with most of the simulant particle sizes, however, optimization of the main pass-through channel would help improve lunar dust resistance in application.

Acknowledgements

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